EXPLORING GHANA'S EXPERIENCES WITH BIOGAS AS AN ALTERNATIVE ENERGY SOURCE

A THESIS SUBMITTED TO THE DEPARTMENT OF SOCIOLOGY AND HUMAN GEOGRAPHY, UNIVERSITY OF OSLO IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF A MASTER OF PHILOSOPHY DEGREE IN DEVELOPMENT GEOGRAPHY

PAULINA DELIA HYDE
SPRING 2010

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PAULINA DELIA HYDE

DEDICATION

This work is dedicated to my loving parents;

Ben and Angela Masopeh-Hyde

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My profound thanks go to the Almighty God for His sustenance throughout this programme. I would also like to thank my Supervisor Aase Lomo for the supervision and constructive criticisms I received from her whilst conducting this research.

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Thank you all.

ABSTRACT

The study focused on two main objectives. First it examined what experiences Ghanaians have had with biogas. Secondly, it looked at the effects of using biogas on the lives of rural folks and women in particular since most rural areas in Ghana are not connected to the national electric grid.

The study area was southern Ghana and the interviews were conducted at three educational institutions, a biogas providing company, local authority and the village of Appolonia where 9 of the rural women were interviewed. The reason behind choosing these various groups as respondents was to get a wide variety of experiences since the study aims at understanding the experiences that Ghanaians have had with using biogas.

From the study it became obvious that biogas technology has not received much patronage among individual households however there are quite a number of institutions that use biogas for different reasons. Some use it as a way to manage human waste and others as a way to follow the green policy in their mission statements.

The greater portion of the discussion however focused on the biogas project that was conducted at Appolonia. The study tried to evaluate why the project came to an abrupt end and how the lives (especially the standard of living) of the rural women were affected when they started using biogas. Effects such as higher incomes and better quality of family life for the women and their families came to light. It was also realized that those women who were involved in selling food benefited more compared to any other group and this may have resulted in those who benefited less refusing to pay the monthly levy needed to sustain the project.

The findings that came to light gave way for some conclusions to be made. The first finding threw more light on the effects of availability of subsidies on biogas projects in rural areas. Biogas though a very useful source of alternative energy is not a competitive fuel source and hence too expensive for the pockets of the poor rural folks. To enable rural people use biogas, there will always be a need for some form of subsidy from an external source to purchase the digester. However subsidy also interferes with their commitment to project.

The second finding was the effect of lack of subsidy on biogas projects in rural areas. It was realized that without subsidy none of the projects can be sustained. There will always be a need for an external source of funding, whether from the central government or NGOs. Even

in the urban areas where the standard of living is relatively higher as compared to rural areas: the low patronage of biogas is attributed to the high cost of the biogas digester.

The third finding was that the leadership of a community influences community participation level in a project and this goes a long way to determine if the project will be sustained or not. For instance in communities where the leader (usually a chief in rural areas), is not a visionary, he or she may not be able to anticipate the needs of the community ahead of time which means that community will always be behind in terms of technology. Also in the communities where the people are not involved in decision making, the project tends to stall either because the project does not meet the needs of that the community or that the community members have not been educated on the potential of the project to benefit them. Communities with high level of education also give their best to community projects since the members have in depth knowledge of the potential of the project to benefit them.

The question then is whether promoting biogas usage in rural communities can be sustained or not. The examples in Ghana, India and China definitely does not support that premise. However biogas certainly does improve the living standards of rural women. It seemed clear that at very low standard of living, as is the case in rural areas the biogas produced by the domestic digester is just sufficient to meet their cooking and lighting needs. As the standard of living rises and other household electrical appliances are purchased the biogas that is produced by the domestic digester is no longer adequate to meet the household energy needs. When subsidy and technical support and commitment are present: at a low standard of living, biogas usage in rural communities is sustained. However at relatively higher standard of living even with available subsidy it is not sustained.

It was therefore concluded that biogas technology was best for waste management in both the city and rural area.

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ABBREVIATIONS

AFPRO - ACTION FOR FOOD PROGRAMME

CSIR – CENTRE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

CSIR-IIR - CENTRE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH-INSTITUTE OF INDUSTRIAL RESEARCH

GDP - GROSS DOMESTIC PRODUCT

HDI - HUMAN DEVELOPMENT INDEX

KNUST - KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

LPG – LIQUEFIED PETROLEUM GAS

PTA- PARENT TEACHER ASSOCIATION

SESAM – SUSTAINABLE ENERGY SYSTEMS MANAGEMENT

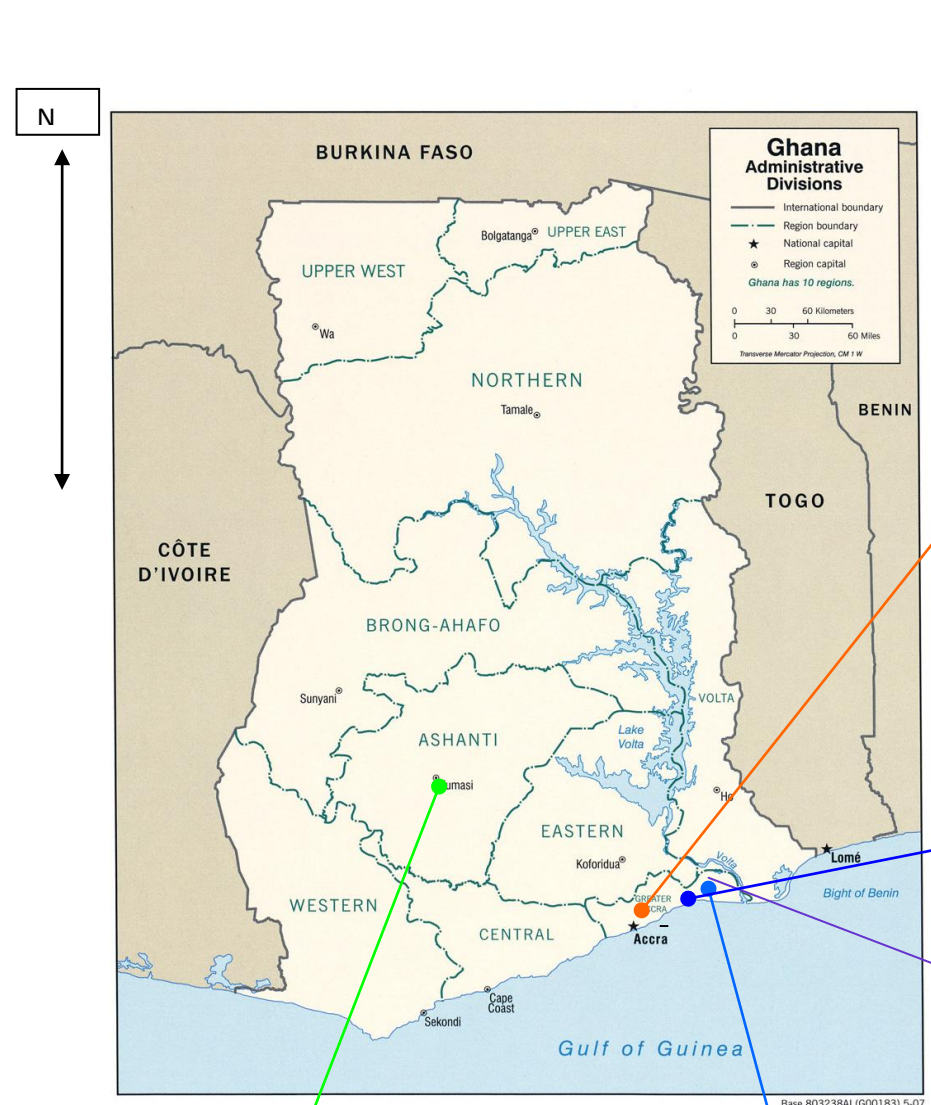
TMA - TEMA MUNICIPAL ASSEMBLY

UN – UNITED NATIONS

USD - UNITED STATES DOLLAR

VVU - VALLEY VIEW UNIVERSITY

Map of Ghana showing locations where interviews were carried out.



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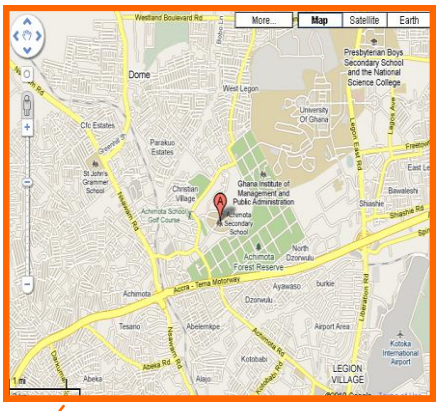

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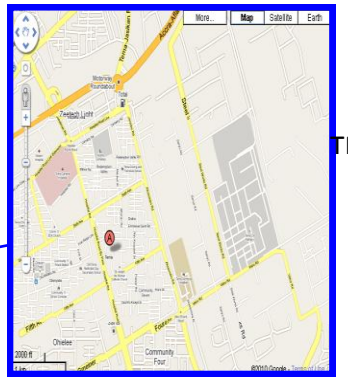

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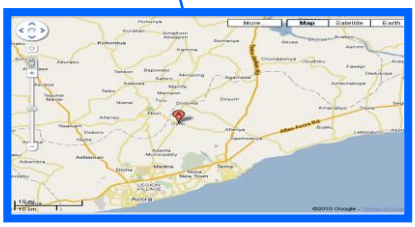
Appolonia



VALLEY VIEW

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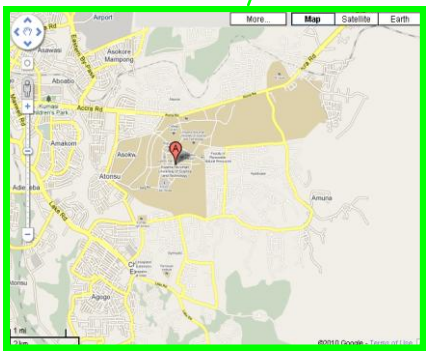

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CHAPTER ONE

INTRODUCTION

1.1 Background to study

This thesis seeks to find out the kind of experiences Ghanaian communities have had with biogas technology usage in their everyday lives.

Energy has now become a very common word that cuts across all fields of study. Accelerated population growth and emerging alternate use for energy has threatened the world energy supply resulting in the thirst for alternative energy. In the rural areas of Ghana the main fuel for fire is firewood which is basically dried tree stems, branches and twigs. Women do the cooking and to start a fire they need to walk several kilometers in search of wood before coming to the actual cooking. Other duties such as household chores childcare and farm work must also be attended to; this entire work load makes life very unbearable for the women. Having an alternative fuel can therefore change the lives of the women in more ways than one in addition to increasing the time they have to attend to their personal needs. The burning of firewood produces large quantities of carbon dioxide which causes a lot of respiratory problems to rural women each year (Zeleke 2008). The carbon dioxide produced from the burning fuel wood has no sink to absorb it because the forests which are cut to make the firewood are not given enough time to rejuvenate. The use of firewood contributes to global warming hence the need for a better alternative (Reardon & Vosti 1995).
The very popular alternative energy sources are wind, nuclear, solar and not so popular biogas energy. The alternative energy sources are used to supplement the most common energy source which is fossil fuel however they are not without their own disadvantages.

1.2 Some alternative energy sources

Wind

Wind energy is clean and easily accessible. It is harnessed through the windmill. The wind turns the fans of the windmill which is connected to a turbine that converts all that mechanical energy into electricity. The process when described sounds quite simple hence one cannot help wondering why wind energy is not being used all over the globe. In general wind energy is harnessed only by the developing countries like Holland, United States of America and

United Kingdom with Denmark leading the way. This is because the cost of one wind mill is over 2 million US Dollars which is quite on the high side considering the fact that more than one windmill is required to provide electricity for a community of about 3000 members. The technology involved also means that the developing countries cannot produce the windmills on their own in order to reduce the cost of production neither are they regarded competent enough to operate such complex technology. It thus explains why developing countries are unable to partake in this otherwise clean alternate source of energy.

Solar energy

Solar energy is abundant in quantity and free yet why is every one not driving solar powered vehicles and using solar panels to power their homes? These questions are worth asking because in their answers lie the solution to encouraging people to embrace alternative energy more tightly. The solar panel has a surface full of photocells that absorb solar energy when exposed to the sun and convert this energy to electricity. It is usually placed on the roof of buildings where there is minimal shade. A solar panel with dimensions 100cm x 50cm is able to cater for the electricity needs of a family of 5 for 10 years after which it must be replaced. The cost is about 2000USD which is comparatively modest considering that it represents the electricity bills of an average Ghanaian home for a decade. With so many savings to be made, it is very surprising that there are very few solar panels, even in the capital city of Ghana. However with average wage being less than 2USD per day it will be very difficult for many Ghanaians to afford solar panels. Even if they can, it will mean several years of savings in order to raise the initial cost. That is not to say that financial constraint is the sole reason why the roofs of Ghanaian homes are not spotted with solar panels. However the most obvious reason is the only one being stated here since solar energy is not the focus of this thesis.

Nuclear energy

Nuclear energy is also a very potent energy source. In fact it accounts for 30% of China's energy base which implies that nuclear can cater for a substantial amount of Ghana's energy needs. But with a past filled with incidents such as the disaster at Chernobyl, nuclear energy has become infamous and its usage is now under maximum surveillance from the international community. With nuclear the minutest of mistakes will be blown out of proportion in a massive disaster that takes centuries to correct. Even in the advanced counties where precision is high, one cannot be too careful since nuclear disasters can affect areas beyond just the local area where an incident occurs. No wonder states like Iran and North

Korea are under such scrutiny from the international community because of their nuclear programmes. Needless to say, nuclear energy may have potential to be an alternative energy source but its safety is a big issue since it has the ability to render large land areas uninhabitable.

Biogas energy

Now to the focus of this thesis which is biogas. It is the end product of anaerobic reaction and is able to provide electricity to light up homes and also gas for cooking purposes. The raw material needed is any biodegradable material hence it is a good way to deal with biological waste such as human and animal excreta, kitchen and farm waste and even biological waste from hospitals. Human excreta due to it's low nutrient content is seldom used as fertilizer, hence with such large quantities being produced in the cities the fastest and cheapest way to dispose of it is in the sea. Whereas if it is used as a raw material for biogas production, the effluent that comes out as byproduct is high in nutrient and very good when used as fertilizer (Hervie 2008).

Hospital waste is usually incinerated but this method does not give back anything in return as biogas does. In addition, with recent talks about global warming, burning to release more carbon dioxide fumes is not particularly appropriate. Biogas production on the other hand is a clean way to produce energy and tackle waste problems at the same time. With such aggravating waste management issues in the city centers: it is a wonder that the Ghanaian authorities have not done much by way of investigating how they can harness biogas technology to produce energy and at the same time cleanup some of the waste.

Moreover, Ghana's fifty years experience with hydro-electric power could not ensure complete electrification of the rural areas so biogas seems a more appropriate alternative. The raw material for the biogas production is organic waste from animals, kitchen waste and farm waste (Adeoti et al. 1999). These ingredients are all very easy to come by in the rural areas of Ghana since farming is their main employment. Is it possible then for small rural communities to be independent energy wise?

The Chinese government with the help of the International Fund for Agricultural Development (IFAD) has helped in the installation of several biogas generating systems in the rural areas of China and this project has been praised by the rural folk since it has helped to meet their fuel needs. Apart from the cost of the tank the raw material is virtually free.

1.3 Problem Statement

Rural communities especially the women living there have a hard time meeting their fuel needs. So much time is spent looking for firewood that they have very little time to attend to their personal needs and economic activities. If there is a way to relieve these rural people from this burden in order for them to concentrate more on improving their living standards then that option must be explored. Biogas has so many advantages to offer the Ghanaian; this thesis is therefore trying to explore those advantages of biogas and how they relate to improvement of the living standards of rural women in rural Ghana.

1.4 Hypothesis

The argument in this study is that biogas does improve the standard of living of rural women and secondly that the biogas projects in rural communities can be are sustained.

By using biogas instead of firewood, the excess time that is gained can be used by the women to engage in economic activities thus increasing their income levels and subsequently their standard of living. Secondly the rural women can save precious time that can be used for other activities such as caring for their children.

The clean nature of biogas can also ensure that the respiratory problems that accompany the use of firewood are curbed thus promoting good health among rural women and the rural community at large.

1.5 Objectives of the Study

The main aim of this study basically is to find out what experiences Ghanaians in general have had with production and usage of biogas as an alternative energy source.

Secondly, to find out what possibilities there are for dissemination of biogas technology to rural people in Ghana since most rural areas are not connected to the main electricity grid.

1.6 Justification

This study is relevant because it will bring up some of the experiences that Ghanaians have had with biogas.

Secondly it will help to know the way forward in terms of biogas dissemination to rural communities in Ghana. This is very important because rural communities cannot afford electricity even if they are put on the national electric grid. However biogas can serve as alternative energy source for them. Using biogas also has the potential to improve their standard of living both financially and emotionally. Time spent collecting firewood can then be spent on children or on economic activities thus leading to increased income.

1.7 Structure of the Thesis

The framework of this thesis will comprise six main chapters.

Chapter one

The first chapter will introduce the study, the problem that has necessitated the study. It will also touch on what this study hopes to attain and the justification as well as an overview of the layout of the study.

Chapter two

This chapter will discuss the methodology of the data collection. It will touch on the sampling method, research instruments and the techniques that will be used to analyze the data. In addition to the above, it will raise issues about the validity of the data collected and the limitations that may have risen due to the method used to collect the data. This structure will help set the ball rolling for the data analysis in the chapters to follow.

Chapter three

Chapter three is the conceptual framework. It will discuss different concepts of standard of living. It will also touch on some of the issues surrounding the ownership of biogas digesters

which include subsidy and community participation. These concepts will help to analyze the data that was collected during the fieldwork.

Chapter four

Chapter four is a review of varying and unique experiences that certain developing countries have had with biogas and the lessons that were learnt. This is done with the intention of discussing important issues that have been raised about biogas dissemination in the developing world. . The countries that will be focused on are: China, India Ethiopia and Nigeria.

The chapter will have two sections. The first section will discuss biogas dissemination in the countries mentioned above. The second section will try to capture how using biogas has improved the lives some rural women in the developing world.

Chapter five

In this chapter, the data collected during fieldwork is analyzed. This will be done in light of the reviewed literature in the conceptual framework.

Chapter six

Chapter six is the concluding chapter. It will be devoted to conclusions that will be drawn from the discussions that will ensue from the data analysis. These conclusions will aid the policy initiatives of any institutions that may deem the findings useful.

1.8 The Study Area

General Country Profile

The study was conducted in the southern part of Ghana. Ghana is located in West Africa. It is bordered on the north by Burkina Faso, on the east and west by Togo and Ivory Coast respectively. On the south Ghana is boarded by the Gulf of Guinea. The country has a land

area of u 238,535 km sq and a total population of 23,837,000 as at January 2009 (Ghanaweb.com, 20th September 2009). Agriculture accounts for 37.3% of the country's Gross Domestic Product (GDP) and also employs 56% of the labour force comprising 11.5 million people.

According to World Bank reports, the per capita income of Ghana as at January 2009 is $1563.74USD, however approximately 30% of the population of live below the UN agreed poverty line of $USD1.25USD per day.

The culture is diverse due to the many ethnic groups. As at 1960 when the country gained independence from the British about 100 dialects was recorded as being used by the populace.

Ghana is divided into 10 administrative regions and these have been sub-divided into 123 districts.

The data was collected in two separate regions namely the Greater Accra and Ashanti regions. The data was gathered from 5 institutions and the community of Appolonia. Below is therefore a short profile of Appolonia

1.9 Area Profile of Appolonia

Appolonia is located in the Greater Accra region in southern Ghana. The community is about 46km from Accra, the capital of Ghana. As at 2004 the total population was 1500 heads however Ghana has not had any census since year 2000 so a new count is yet to be known.

The biogas project at Appolonia known as the Appolonia Integrated Rural Energy Project was finally commissioned in June 1992 by Dr (Mrs.) Mary Grant, the then Health Minister of Ghana. The main aim of the project was to introduce biogas as an alternative fuel for rural communities in order to decentralize them (rural communities) from the national electricity grid.

A total of 10 digesters which had a capacity of 50cubic meter each were constructed. The digesters were constructed with bricks and each had a retention time of between 50-60 days. The biogas produced from the digesters was connected to two engines which then generated electricity for the whole community.

Smaller digesters of between 10 and 15cubic meter capacity were also constructed close to the households in which case 3-4 households shared one. These smaller digesters were solely for the purpose of cooking. It was maintained daily (charged) by the caretaker.

As at 2004 the Appolonia Integrated Rural Energy project was no longer running for several reasons which will be discussed later in the study. The biogas digesters are broken down and no longer in use. The pipes that once channeled the gas to the households are all currently choked with sand and rubbish.

The generators on the other hand are still in use. However they currently run on diesel to generate electricity hence when any member of the community needs electricity for a function they provide the diesel. This however provides electricity not only for the individual but for the whole community.

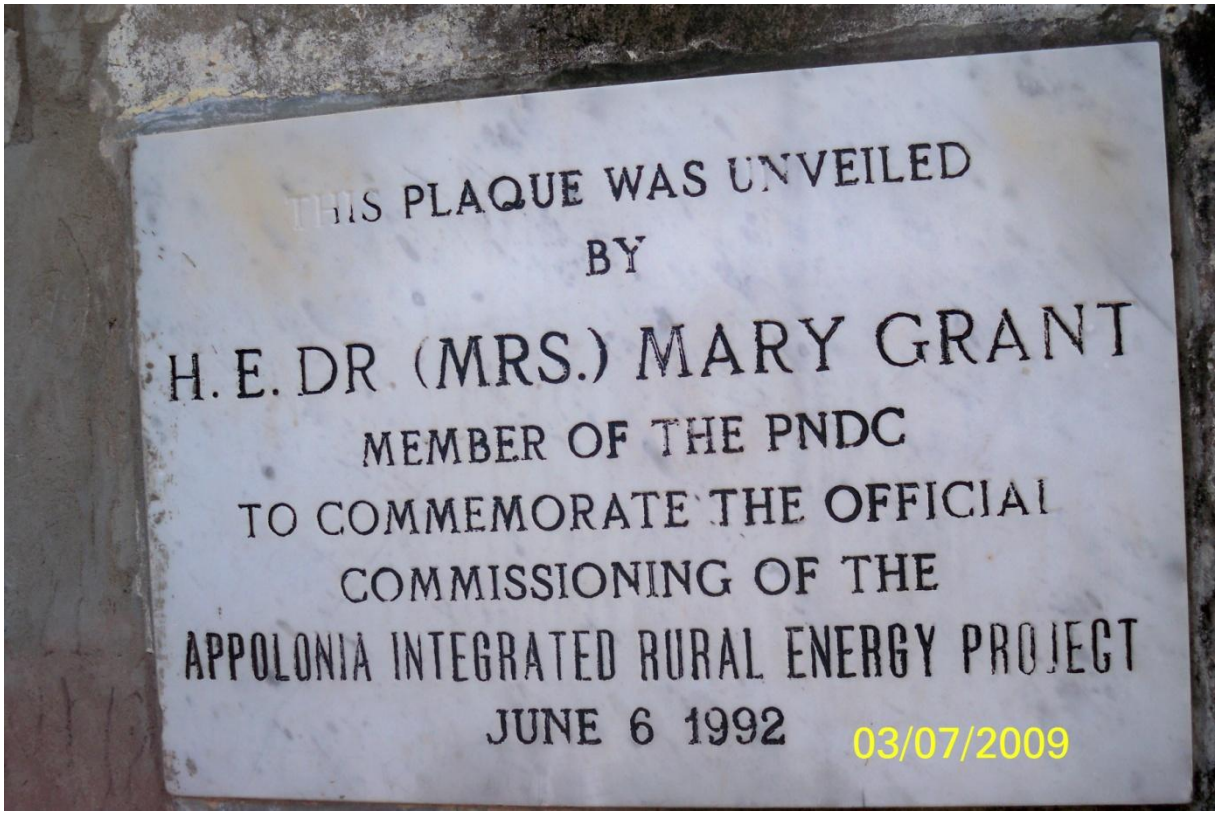

Figure 1.1: Commissioning plaque of the biogas project at Appolonia

CHAPTER TWO

RESEARCH METHODOLOGY

2.1 Introduction

According to Charles C. Ragin, social research is about trying to match ideas with evidence. The aim of this study as stated previously is to assess the possibilities of producing biogas in rural communities in Ghana, especially for the benefit of rural women considering the fact that integration of biogas technology has been successful elsewhere in other developing countries. This is be done by exploring the experiences that Ghana as a country has had so far with biogas.

This chapter therefore presents and discusses all the processes that were considered and employed in the collection and processing of the data to serve as supporting evidence for this research. It also touches on the research design adopted, the target population, sampling size and technique used as well as the instruments used to process the data.

2.2 Type of research method

As Blumer put it in his work, *symbolic interractionism*, methods are used merely to understand and explain the nature of the empirical world and hence their value is judged according to how well a method is able to execute this task. The aim of collecting the data is to get a hold of the different experiences that have been encountered from using biogas as an alternative energy source in Ghana. The aim was therefore to interview people who have had some form of interaction with biogas no matter how minimal the interaction maybe.

The study is intended to be exploratory and discursive hence the need to use qualitative methods. This cannot be achieved by a single qualitative method so a method of triangulation is employed at various stages of the study. Triangulation involves the use of several methods at a time so that the methods compliment each other. The strength of one method helps to overcome the weaknesses of another thereby achieving a cost benefit analysis balance, (McIntyre 1999). The qualitative methods triangulated in this study include interview, informal discussions and observation.

In recent times the naturalist and positivist views of gaining knowledge have become the standard by which almost all the fields acquire knowledge. Proponents of naturalism propose that as much as possible the world should be studied in its natural state. For that reason methods of collecting data such as formal interviews and experiments defeat that purpose of gaining knowledge in a natural setting, (Hammersely and Atkinson 2008).

According to the naturalist, the research or method of gathering must also be true to what is being studied hence social research cannot be carried out in the way that physical phenomena is studied. It has been proven in several studies and is a well known fact that humans behave differently when they are alone and when they know they are under scrutiny. As such, in social research subjecting humans to laboratory conditions does not give out the true impression of the situation at hand and therefore a skewed data is obtained. Blumer explains it better in this paragraph taken from his 1969 work on Symbolic interactionism:

"…. Method are mere instruments designed to identify and analyze the obdurate character of the empirical world and such their value exists only in their suitability in enabling this task to be done. In this fundamental sense the procedures employed in each part of the act of scientific enquiry should and must be assessed in terms of whether they respect the nature of empirical world under study – whether what they signify or imply to be the nature of the empirical world is actually the case…." (Blumer 1969)

Is that supposed to mean then that no credible data can be obtained from studying humans who have been isolated from their natural setting? Come to think of it the data that is obtained through interview also has the potential of being skewed since interviewees may also act differently or give wrong information due to how they view the interviewer. Even in participant observation when the researcher does not reveal their identity, the presence of a foreign entity (in this case the researcher) in the social setting can cause the members in the society to act in a way that is not true to their nature. Therefore choosing qualitative or quantitative does not mean that the data that will be obtained will be without blemish, however as I researcher tried to ensure that as much as possible the method chosen will produce the best data possible given the available resources.

The positivists on the other hand advocate for sense experience. They believe that true knowledge should be gained through what is known today as the scientific method. The way to gain knowledge according to this school of thought is to systematically test what is observed and make generalizations from the outcome, (Smith et al. 1996).

According to Rene Descates, sense experience does not give certainty because it does not answer very fundamental questions like the mind-body dichotomy and dualism of the human being. He does come to the conclusion that being able to be critical about an issue is certainty of one's existence. Actually what is fact today remains so only because it is yet to be proven otherwise.

The choice of qualitative method for this study rather than quantitative was due to the fact that it was the method that best suited the study. The study did not aim at representing all the different individual reasons behind Ghanaian attitude towards biogas. If that was the case then quantitative method of data collection would have been more appropriate. And besides for a quantitative study to be a true representation of the population under study a large sample size is recommended however that is not the case with biogas projects in Ghana which are very few. My aim as a researcher on the other hand was to gain deeper understanding about the dynamics of the diverse experiences that Ghanaians have encountered by using biogas. This did not require a large sample but rather in depth illustration of the driving factors something which could not easily be captured by quantitative method.

Qualitative method is a more flexible way to collect data as such it helps the researcher to produce a more diverse view of the phenomena being studied. It also has descriptive advantage over the quantitative method which enables the researcher to present the world in a way that numbers just cannot do. And last but not least qualitative method allows the researcher to interact with those being studied in their own language.

By the above I mean to say, the interviewees do have to choose from a limited option what words to describe the phenomena or situation with, because the flexibility of a qualitative study allows them to use their own words and as such they can call in situations that may have been overlooked by the researcher.

This is not to claim that the chosen method is without shortfalls in its ability to capture and analyze data, because unlike quantitative method, with qualitative method absolutely different conclusions can be arrived at given the same data, it depends to large extent on the

researcher. Secondly, with qualitative method it is very easy to sway from the initial objects of the study due to its flexible nature.

The questions asked during the interviews and observations conducted, all helped in throwing more light on Ghana's experiences with biogas production and usage over the years.

2.3 The Study Area and Target Group.

The study was conducted in the Ashanti and Greater Accra Regions of Ghana.

Educational institutions, villages (Appolonia) and individuals were interviewed.

In the Ashanti region, the sight visited was the Kwame Nkrumah University of Science and Technology (KNUST). This institution as the name implies is one of the public universities in Ghana that was established in 1952 to focus on dissemination of science and technology. The faculty of agricultural engineering of the university has a biogas digester which attracted my interest hence and that is the reason why the school was included in my list of institutions to visit.

In the Greater Accra Region, I visited other educational institutions but before hand I knew two of them have some experience with biogas digesters. The schools visited were Valley View University, Achimota School and Sakumono School Complex.

Valley View is a relatively new private university in Ghana which professes to follow a green policy and hence the construction of three 30 cubic meter biogas digesters in 2005 to convert the liquid waste from the school into energy.

Achimota School on the other hand has been in existence for over 80 years. It is a senior high school with student population a little over 1000 and an ongoing biogas project at least so I thought since I was once a student there: until I was told by the headmistress on the day of the interview that the project had been abandoned some years ago.

The reason for visiting these institutions (with the exception of Sakumono School Complex) was to find out their reasons for venturing into biogas technology and their experiences with the technology so far and to also discuss issues such as maintenance and sustenance of their respective biogas projects in general.

The third school as mentioned above is Sakumono School Complex. This school unlike the others does not have an ongoing biogas project so my intention was to use the institution as a point of comparison to find out why this school and other schools like it have not ventured into biogas technology.

I also had the opportunity of visiting the community of Appolonia. Appolonia is a rural community also in the Greater Accra region of Ghana where a biogas household programme was initiated in 1986 and commissioned in 1992 by the then Ghanaian Ministry of Energy. The aim of the project was to provide the community with street lights and energy for the households. The community was into cattle farming thus availability of cow dung to charge the digesters was assured.

In all, a total of six 15 meter cube, eight 10 meter cube digesters were constructed for the purpose of the Appolonia household programme (Amissah–Arthur and Amoonoh-Anamuah 2004).

The Tema Municipal Assembly, one of the district administrative authorities in Greater Accra region was also contacted to give their impressions about biogas and their policy intentions in the future in regards to adopting biogas technology as a way to provide energy in the Municipal assembly.

Then finally, an up and coming company known as Biogas Technology for Life (BTL), that constructs customized digesters was also contacted. The intention was to get an idea about the commercial nature and cost that would be incurred in order to own a digester.

2.4 Sample Size and Sampling Procedure

In all a total of sixteen respondents were selected for this study. (Alreck and Settle 1985), advocate that a sample should represent a tenth of the entire population being studied. However (Fraenkel and Wallen 2003), on the other hand emphasize that the best sample size is one that is large enough for the researcher to obtain the kind of data that expresses the diversity of the experiences for the study. As mentioned before, this study is more about representing the diversity of experiences as such a large sample was not my focus but rather a diverse sample to represent variety.

The procedures used to decide the sample size include purposive and snowball sampling techniques.

Purposive sampling involves selecting the sample that can give the most information for the study. In the case of this study, I used purposive sample to select the people who have actually encountered and experienced biogas such as Achimota School, Valley View University and the Appolonia community.

The snowballing on the other hand is where the researcher is referred to other sources of information and resource persons by the initial respondents. In fact most of the respondents for this study came about through snowball sampling technique since they were recommended by members of my purposive sample.

The Tema Municipal Assembly is one such institution which was referred by my respondent at Valley University to me.

Table 2.1: Sampling distribution

Institution	Number of females interviewed	Number of males interviewed	Total number of people interviewed
Achimota School	1		1
Appolonia	8	1	9
Biogas Technology Limited (BTL)		1	1
Kwame Nkrumah Uni of Sc & Tech (KNUST)		1	1
Sakumono School Complex	1		1
Tema Municipal Assembly (TMA)	1	1	2
Valley View University (VVU)		1	1
Total			16

Source: Fieldwork

2.5 Data Gathering Techniques

The data used for this study was gathered from a total of sixteen people through formal and informal interviews as well as my personal observations. A semi structured interview guide was used to collect the qualitative data needed for this study. Two different interview guides were put together: one was intended for the respondents who have had some form of interaction with biogas and the second was for the group of people who have had no experience with using biogas.

The decision to use the above mentioned techniques is an informed one based on the relative ease of their execution, comparatively lower cost and the fact that this work is a qualitative study. In the paragraphs below, the two main techniques used have been expatiated.

2.6 The Interview Process

The aim of the interviews conducted was to find diversity of experiences with biogas among Ghanaians. Rather than administering a questionnaire an interview guide was used so as to bring out the actual perceptions of the interviewees and also to explore other issues that the questionnaire may not have covered. As mentioned earlier, two different interview guides were used, one was directed at those who have ever used biogas and the other was for those who have never used biogas. Though the interviews were scheduled, they were conducted in a very informal and relaxed manner in order to avoid the situation where respondents feel intimidated though I must confess that some of my interviewees did feel intimidated and hence would not allow my use of a voice recorder.

According to Seidel (1998), in-depth interviewing helps the researcher to understand better, the experiences of the respondents and the meanings that the respondents attach to their experiences. The semi structured nature of the interviews therefore equipped me with the flexibility needed to probe further where necessary and to make adjustments to the questions asked when the situation demanded.

This is not to say that interviews have no weaknesses because the process of interviewing can be very time consuming and often times interviews exceed their scheduled duration.

Secondly the problem of language barrier is often experienced by researchers but in the case of this study I had in-depth knowledge of the local language and therefore had no problem

communicating with my respondents. Many researchers caught in this web try to employ the services of one of the locals as a translator but many a time, conveying the true meaning of sentences can be more complex than imagined especially when the translator does not understand fully the real meaning of the questions.

As a researcher, I also faced the problem of wrong impressions perceived by the respondents or created by the researcher. When respondents perceive the researcher as a personality they cannot trust, information is very much withheld. On the other hand when respondents view the researcher as a source of help they tend to exaggerate the information.

In my case I experienced the latter situation during the interview process at Appolonia. Most of the women perceived me to be a government agent who may be coming to help revive the biogas programme that was brought to an abrupt end. As a result I did sense that most of their response to my questions had some element of exaggeration. With experience and proper explanation to the respondents (which I vehemently did) this particular problem can be overcome.

I reckon that being a local from the study area (Greater Accra region), also presented me with some advantages as well as disadvantages. Having my own personal perceptions acquired from being a native of Ghana may have generated some form of complacency on my part. For instance in my posing of questions I may have assumed the response that I will get and hence my not asking the questions at all.

A foreigner on the other hand would have asked more in depth questions than I did due to their lack of local knowledge. However a foreigner could also suffer the fate of wrong perceptions in the sense of how the locals perceive him or her. Generally locals easily mistaken the presence of a white foreigner in their midst as a source of help rather than a researcher and hence they may be tempted to exaggerate their problems in hope of obtaining some financial aid.

Each interview was prescheduled and the consent of the respondents sought before the interview was carried out. The questions were taken from the appropriate interview guide but follow up questions varied depending on the responses I received from my interviewees.

Apart from the women at Appolonia all the respondents interviewed refused to be recorded on tape so most of the data was recorded manually.

2.7 Observations

The data gathered from interviews was supplemented by observations I made as a researcher. Observing body language such as respondent's countenance, enthusiasm or hesitance, the researcher can tell when to probe further or how to pose a question in order to get the right information without touching any emotional buttons.

In one particular school, the school's head teacher did not want to proceed any further with the interview and from her body language I could sense some hostility at least from my Ghanaian point of view, for that reason I was unable to pose any further questions because I felt intimidated. It was after six months later that I understood why the head teacher had behaved in the manner in which she did. The school's sewage system was broken down, and that was something that could lead to closure of the school: and the head teacher wanting to avoid any form of media attention whatsoever did not trust me to be the researcher that I was claiming to be. However, six months after my visit to the school, this was all over in the newspapers with treats from the Ministry of Health to close down the school if something was not immediately done about the broken down sewage.

However, sometimes body language can be deceptive especially when the researcher is studying a totally foreign culture. In such instances, an attitude which the researcher might interpret as hostile may rather turn out to be a sign of welcome.

2.8 Data Analysis

Data analysis involves all processes and procedure whereby we move from data collected to some form of explanation, understanding, interpreting and basically making sense out of the data (Strauss and Cobin 1990). The processes are; writing, coding into themes and then finding out what available literature there is regarding the research topic.

Remaining open minded is also necessary when trying to uncover what functional relations there are between observations. Strauss and Cobin suggest constant comparison as a way for the researcher to remain open minded. One way of doing this is to look at the phenomena in all ways that other people might see it, even perceptions that may be completely outside the study in order to come out with a holistic view point.

However it remains a fact that in social research remaining totally objective is very difficult since all humans have their personal opinions and have been socialized differently. As a result of this, social researchers concern themselves more with trying to strengthen their hypothesis rather than trying to establishing truth (Willig 2001).

2.9 Limitations of the Study

No research design is perfect, (Patton 2002) and it applies to this study as well. Several limitations can be pointed out in this study but then the design of the research is subject to the kind of data that is being sought after for the study.

One weakness of this study is that though it focuses on rural women, the data was collected from institutions in urban areas. This is however necessary so as to get a wide variety of people's experiences with biogas.

We should also not loose sight of the fact that the standard of living of rural people in Ghana depends on some super structures like policies pursued by the central government and even the international community at large. For instance cocoa price on the world market is what determines the income level of cocoa farmers in Ghana and altogether the amount of economic activity that will take place in rural areas that produce cocoa in Ghana.

Secondly the perspectives and direction of the study is based on interviews with not more than nine out of all the rural women in Ghana, implying that conclusions may not be drawn from the outcome since it will be over generalized. However as explained earlier, this study is not to represent the views of all but rather to understand the dynamics surrounding biogas dissemination and use in rural areas in Ghana.

Finally time and financial constraints did not give me the flexibility to visit as many rural communities as would have been desired. Ideally I could have gone to other regions in Ghana and gained additional experiences. These limitations however do not affect the authenticity of the study and so a lot of lessons can still be learnt from the outcome of this study.

2.9.1 Issues of Ethics and Reflexivity

These are two important areas that should be considered in qualitative data gathering and analysis.

According to Bailey (2006), unlike in the positivist school of thought which emphasizes on objectivity and value neutrality with few reflexive statements: in interpretative paradigm the role of the researcher is highly regarded. What is learnt about an environment and its participants is not independent of the researcher. What ever data was gathered depended to some extent on how much the interviewee trusted the researcher and who they perceived me as a researcher to be. In the case of Appolonia for instance, the women I interviewed perceived me to be a government official and hence did not give the real reason why the biogas supply to their homes was stopped as mentioned before.

The data gathered also depended to some degree on my understanding of the responses that my interviewees gave me. It could be that my understanding of their answers may not be their intended meaning. So to a large extent what will be known depends on the personal perceptions and opinions of the researcher.

2.9.2 Maintaining Objectivity

Remaining objective is quite challenging when there is prior knowledge of situations on the ground, for instance in the case of this study, being a resident of Ghana for a long time prior to the study I was aware of the attitude most rural communities in Ghana display: they wait on the central government to initiate and fund all projects concerning them. The temptation to look at the issues with previous knowledge was constantly there. It does not however mean that my personal impressions and opinions as a researcher are completely wrong or invaluable for the study. However, had I been an outsider, I would have asked more questions and obtained more from the interviews than I did. There may have been an element of complacency on my part as a researcher simply because of my Ghanaian background. It is possible therefore for a qualitative study to be completely objective without any hint of subjectivity from the researcher?

2.9.3 Ethics

The issue of what is ethical or not always crops up in any research. The debate heats up even more when cultures are interplaying especially when the researcher is from a totally different social setting from what he/she is trying to study. Ethics are not only observed during data collection processes, it is more important in analysis since from there one proceeds to write the final manuscript.

Several issues are raised when it comes to ethics however I will focus on consent and exploitation.

2.9.4 Consent

It is very important to seek the consent of the interviewees before including them in the research. They also need to know what the data is for and where it will be published however (Hammersely and Atkinson 2007), argue that sometimes the sheer number of respondents required for a research makes it impossible to seek the consent of all and that if this had been thoroughly followed many researches would not have been carried out. As researcher I advocate that if the respondents are kind enough to share their experiences and time with you then the least I can do is respect their demands as to what personal information can be published or not.

Another instance when permission must be sought from the interviewee is the use of real names and locations in the thesis since it can violate confidentiality agreements if such are made. This is important because the use of such personal information can result in readers being able to identify the respondents which may result in harm or embarrassment to them, (Hammersely and Atkinson 2007). In his book on high risk methodology, (Wolf .D 1991), gave an example of how personal information can bring harm to the interviewee.

Wolf having been a member of a Chalgory chapter of rebels wrote a thesis mentioning them. A prosecutor then used the information from the thesis to try and revoke a member of the Chalgory's firearms acquisition certificate. The rebel member won the chase but went to Wolf with the intention of trying to settle a score with him.

There are exceptional cases where one can resort to using names but permission must be sought (Bailey 2006).

During the data gathering process of this study most of the respondents objected to the use of audio recorder and their request had to be duly honoured.

2.9.5 Exploitation

There is always a possibility to exploit the respondents by using the data for something else apart from the agreed purpose. Some respondents never get a feed back from the research as to how the research will improve their lives or even perhaps payment for their time spent with the researcher, (Hammersley and Atkinson 2007) however even when you as a researcher think you have paid a reasonable amount to the interviewee, the amount you give can be branded as exploitative as (Howarth 2002) experienced during her data gathering process. She narrated how she had been attacked by the interviewees for exploiting her even though she had paid them a fair amount for their contribution to her study.

In my case I was advised by my local escort on the amount to give to the individuals I spoke to at Appolonia and hence I did not experience any issues of that nature.

What decisions you take in regards to trying to avoid exploitation of the respondents is dependent on the particular situation being faced; there are no hard and fast rules.

CHAPTER THREE

CONCEPTUAL FRAMEWORK

3.1 Introduction

Rural women who use biogas as a source of energy for cooking and lightning have had some positive experiences to share about how the biogas technology has improved their standard of living. What this section seeks to do however is to clearly specify what standard of living refers to particularly in this thesis.

The chapter will also discuss some of the issues that emerge during the implementation of biogas projects. These include; ownership problems that arise when biogas digesters are funded by external sources also and community participation.

3.2 Standard of living

According to Sen (1984), there are three ways of discussing standard of living. The first way is to look at standard of living as real income or the bundle of goods that an individual's income can purchase. But Sen explains that this way of looking at a person's welfare can be problematic because it measures standard of living in a purely materialistic way. For instance, if one owns a Lamborghini (which is a very expensive race car reserved for the affluent in society), it does not imply that the owner necessarily lives a fulfilled life especially if the owner does not enjoy driving very fast. In short being able to afford a large bundle of goods does not necessarily imply a high standard of living.

Rather attention should be given to the content of the bundle of goods that is being purchased as against the needs or desires of the individual. This is because if the owner of a Lamborghini loves to drive fast then desire has met what is being desired hence the individual can be said to be happy.

However some people glory in being needy due to religious affiliation and by their religious or other explanations they claim to be living a fulfilled happy life though they lack the basic essentials. Can we then say that such people are living a higher standard of living than the rich man who is not happy with his abundance of goods? We can if we equate happiness to standard of living. However from Abraham Maslow's theory of need, we can say that at least

the basic needs of food, clothes and shelter must always be ensured and included in any measurement of standard of living.

The second way of discussing standard of living according to Sen, is in the context of National Income and per capita income. But this is actually the first one discussed above in disguise according to Sen.

The third way of looking at the subject of standard of living is freedoms. By freedoms Sen refers to the freedom that an individual gains or has to live in a certain way that they wish. He refers to the capabilities that an individual may possess to prevent him or her from starving. Here emphasis is placed on the capabilities that real income gives to an individual rather than the mere possession of a high income, how the possession of a high real income enables an individual to live the way they want to live. In other words, this way of looking at standard of living is more focused on the intangible aspects of welfare, like safety and assurance that one not necessarily gets but feels from knowing that they have starks of money stored at the bank for a rainy day.

Sen therefore highlights two main ways of assessing standard of living, material or monetary terms and then intangible terms. Let us look at another index for measuring standard of living.

The United Nations (UN), uses the Human Development Index (HDI) to measure the overall standard of living of people the world over.

The UN Human Development Index tries to measure human development using less of the monetary concepts such as Gross Domestic Product (GDP), and more non quantifiable concepts like emotional health, mental health and educational attainment. The index takes into consideration the things that determine the quality of life of a person rather than the monetary wealth one has amassed, for instance, intangible and non quantifiable concepts such as emotions, mental health and literacy. The index therefore has three measuring indicators; the first is the standard of living, then educational attainment or literacy followed by life expectancy. The measurement of standard of living by the UN human development index uses the natural logarithm of gross domestic product (GDP) per capita at purchasing power parity which is quite monetary. Any reference to standard of living in this paper implies intangible but very important indicators such as, mental and emotional health, literacy and over all physical wellness.

(Paul Glewwe and Jacques Van Der Gaag 1990) made a very important observation in Cote D'Ivoire, the country on the west boarder of Ghana, in their paper they found that depending on what definition one uses, a different set of people will be identified as poor.

Glewwe and Van Der Gaag used several indexes such as, household consumption, per capita income, per capita food consumption, basic needs and food ratio to name but a few.

They realized that each of the indexes had a short fall in identifying the real poor in the society and some were more appropriate for a rural setting than for an urban setting.

For instance using the household consumption index indicator gave the impression that majority of the urban poor live in Abidjan. However this index does take into consideration the fact that the average household in Abidjan is 10.8 persons per household and 14.1 in the other major Ivorian cities hence consumption of resources per household will definitely be higher in those cities as compared to households in Abidjan.

The agricultural land per capita index is also very appropriate for identifying the poor in farming communities in rural areas. In this case the poor will be those lacking land for farming. However when it was used by Glewwe and Van Der Gaag, the index also included the very well off families living in farming areas and yet whose incomes came from white collar jobs rather than farming as poor.

Another approach used to identify the poor was the Basic needs approach. Here the definition of poverty was based on whether the food, clothing, shelter and health needs of the people whose standard of living is being assessed are being met.

This index proved a better option compared to the others but then a question of how objective the index is was raised. For instance how does one determine the acceptable level of education or health care?

This was very problematic since most policy makers depend on these erroneous measurements when distributing their country's resources. They concluded by recommending that data collected should be more comprehensive to show all the facets of poverty because poverty does have many ways of showing itself apart of malnutrition and disease.

When it comes to the effects that using biogas has on standard of living what then is the appropriate definition for poverty in regards to rural women like those at Appolonia?

In this thesis however, any reference to standard of living means any slight increase in real income that leads to higher purchasing power since having a higher purchasing power means one can afford better health care and nutrition as well as access to education. It also includes emotional and mental health. For instance any activity that increases the time that the women can have to attend to their personal needs and that of their children and even for them to take time off to rest.

The Paradox of Subsidy and Community Participation

3.3 Introduction

As explained previously, subsidy is very crucial in the attempt to disseminate biogas to poor rural communities; however subsidy creates a problem in the dissemination attempts. Generally in cases where biogas digesters have been subsidized the owners do not display any commitment towards the digester. They do not show any proper responsibility in terms of maintenance or even finding out how they can benefit fully from the biogas project

The digester is too expensive to be afforded by poor rural folk, yet when help comes in the form of subsidy it interferes with commitment to the project: what then should be done in order to tackle this issue?

The issue at hand then is how to mobilize whole communities to participate in biogas projects and for community members to be in charge of the sustenance of biogas projects.

3.4 Encouraging Community Participation

The domestic users of biogas do not have any feeling of owning the digesters hence when they encounter any problems in the usage of biogas digesters the digesters are abandoned. How then can you get such people to be committed to the sustenance of the projects?

(Squazzoni 2008) expressed the tremendous importance of Community Development Corporations (CDC) in such situations. In his paper, he labels CDCs as carriers of local economic initiatives.

CDCs promote development through the bottom up approach. The developmental projects are initiated by the people for the people and managed by the community members themselves. Even when funding is obtained from an external source it is the beneficiaries who ultimately decide what use the funds can be put to help them.
Because of the nature of their approach, CDCs more often than not promote projects that are highly prioritized needs of the community members. This implies that community members will have a relatively more positive attitude towards the project since in the first place they initiated it and secondly they identified the project as a need that needed to be met.
When well managed by the CDCs, the community based projects do not serve the needs of the community only but also nearby populations in the form of positive externalities, (Squazzoni 2008)

The CDCs are very helpful indeed but then in the case of a small community like Appolonia where literacy is low and everybody goes about their daily routines uninterrupted who can mobilize the people and spearhead a project. Let us not fail to mention the managerial skills needed to manage mammoth projects like biogas dissemination.
There may be an element of truth in the fact that people need knowledge in order to manage their resources however people do not need formal education in order to be able to identify their own needs. Although people in rural areas lack formal education they still know what their needs are. What they lack however is the know-how to meet those needs for instance, very few illiterates know that human excreta can be used to produce a gas that can light homes and cook food. Knowledge therefore is a necessary tool but that alone is not sufficient.

In time past and even presently, chiefs are the only individuals able to wield the kind of authority needed to mobilize people in a community especially rural settings: so members in a community have to hope that their chief is a visionary who is able to spearhead projects that aim at meeting their needs as a community.
As more members of communities get educated the kind of visionaries needed to mobilize the community members and initiate developmental projects become more abundant and as long as the project is initiated by the people for the people participation and commitment can be assured.

3.5 Summary

To encourage participation, the most important step is to allow community members to initiate and manage the project by themselves for their own benefit. Acquiring knowledge through education both formal and informal is necessary. This knowledge is needed not necessarily to identify the needs of the community members since they already know what they need: but rather to know the trends in science and technology or even managerial skills that can be harnessed to help meet the needs of the community.

Visionaries are also needed to mobilize the community, and these visionaries are also raised when community members yield themselves to education.

CHAPTER FOUR

A DISCUSSION OF SOME ATTEMPTS TO DISSEMINATE BIOGAS IN THE DEVELOPING WORLD

4.1 Introduction

Biogas technology has been used all over the world for several decades with some of the dissemination programmes being more successful than others. This chapter attempts to take a critical look at efforts by some developing countries to introduce biogas technology to their rural communities. The countries that will be focused on are: China, India,Ethiopia and last but not the least Nigeria.

The chapter will also look at how some rural women in developing countries benefited from biogas dissemination programmes in their communities by way of improvement in their standard of living.

4.2 Biogas dissemination in China

China is the largest consumer of biomass fuel today being attributed with approximately 20% of the global bio-energy consumption (Jing Ming 2007). Most of this biomass is used however for domestic purposes like cooking and heating. It is worth noting however that, bio-energy in China is more synonymous to waste from farm lands and livestock rather than fuel wood from the forest hence any growing interest to make use of bio-energy will raise concerns over the land being left bare after harvest rather than deforestation. The Chinese envisioned the potential of bio-energy including biogas in the early 1950s during the reign of Chairman Mao. A lot of funding has been invested into biogas research by subsequent governments since then but this has not been without challenges.

In his paper, (Jing Ming 2007) identified some major challenges that the Chinese faced that can be mitigated by adapting biogas energy. The high reliance on fuel wood has exacerbated deforestation and the extent of this damage is not even certain. Considering that the forests serve as a carbon sink for China's record high pollution levels resulting from their large industrial sector, every effort should be put in place to ensure the existence and perhaps possible expansion of the forests.

Secondly, there is a high earning timber industry that feeds on the high demand for timber and other wood products in China. This demand is quite enormous considering that 56 percent of China's population lives in rural China where firewood is the main source of fuel for cooking. By harnessing the potential of biogas for cooking and heating, the timber industry can be expanded even further since the percentage of wood that is appropriated to be used as fuel wood can be diverted to timber exports.

Thirdly, in a world where resources are no longer sufficient for the increasing pollution, it suffices to say that every venture should be efficient especially when non renewable resources come to play. Unfortunately that cannot be said for the traditional way in which fuel wood or biomass in general is combusted for that matter, (Jing Ming 2007). Improving the way in which fuel wood is combusted so that more energy can be obtained per quantity combusted is definitely in tune with what the modern day term being GREEN is all about. When dealing with any kind of resource, especially non-renewable resource, every measure must be put in place to ensure sustenance and efficiency.

The past decades have yielded very good results from government efforts to mainstream and increase the value of biomass energy and even more especially develop and disseminate the energy technologies (Jing Ming 2007).

In the area of rural energy technology development and dissemination, the most successful project in China has been the National Improved Stove Program: which facilitated the dissemination of stoves to a known 150 million households in the 1990s according to (Jing Ming 2007).

Biogas Technology dissemination in China on the other hand has only been successful in the past decade considering that efforts by the Chinese governments to promote biogas energy among rural China go way back to the 1950s. Between 1980 and 2005 over 11 million households opted for biogas digesters, implying that 8% of rural China were using biogas digesters as at 2005 thus making China the record holder for country with the most number of households with biogas digesters.

This success has been attributed to intense research and promotion in the form of incorporating biogas technology training programmes into their educational curriculum to produce experts who can provide the very necessary after sales services to users of biogas digesters (Jing Ming 2007).

The participant rate in the China biogas dissemination programme has been remarkably high it has not been without challenges. (Jing Ming 2007), outlines the main challenge to be an over emphasis by the China government on quantity rather than quality. The records from the above author indicate that a total of 400,000 digesters were discarded in China in 1984 alone due to them breaking down.

Fingers point to the issue of lack of quality control for the digesters. In a bid to keep costs at the barest minimum, most households construct the digesters themselves. The extension services available is also stretched thin so with households having very little knowledge about the right feed stock proportions, broken down digesters is a very common sight. One will agree that this eye soaring situation is a big blow to the dissemination programme since it is a sounding warning to potential entrants to keep away.

Secondly a lack of technological integration whereby, white goods like freezers and rice cookers that run on biogas are not being produced has resulted in the situation whereby biogas produced in the digesters can only be used for cooking and lighting the households (Jing Ming 2007). This has resulted in biogas usage becoming the reserve of low income families. As incomes increase users of biogas ditch it for electricity since most white goods run on electricity.

Biogas technology is able to meet the energy needs of the poor who unfortunately cannot afford to purchase the digester however those with income levels that can afford digesters are not satisfied with the limited uses that biogas can currently be put to. If white goods such as fridges, television sets, and rice cookers had been developed to be compatible with biogas then perhaps the demand for biogas will be more sustainable due to its versatile utility.

Finally, another important challenge that was made mention of by Jing Ming is the relationship between biogas production and the Chinese pork market. High pork prices induce pork production implying an availability of feed stock for the digesters and in the same way lower feed stock when pork prices drop. The high pork prices are dependent ultimately on the world consumer market which points us to a whole new dimension to biogas usage: international influence on biogas dissemination.

It has even been observed that seasonal rural-urban drift in search of factory work, a demographic phenomenon experienced in China, interferes with much needed labor for maintaining the biogas digesters since the youth and able bodied are those who embark on this

journey (Jing Ming 2007). The youth leave the rural areas to the cities in search of jobs in the industries, thus leaving behind the old to deal with all issues regarding the digesters. Reliance on the limited knowledge of the old people results in the damaging of several of the digesters.

There is also the group that view biogas as inferior commodity that is discarded by higher income level groups. This phenomenon may be explained by the lack of gadgets that are powered by biogas. In their search for luxury goods influenced by their relatively higher income, demand will be directed towards the kind of energy that is compatible to the most number of white, goods all things being equal.

4.3 Biogas dissemination in India

Biogas technology dissemination did not begin in India until 1981 with the launching of the project known as National Project on Biogas Development which was part of the then Indian Prime minister's development plans. The establishing of a ministry responsible for Non-Conventional energy Sources a year later helped to spread further the knowledge and usage of biogas energy in India (AFPRO-CHF/PARTNERS report).

Biogas dissemination in India, unlike in China was decentralized by the Ministry in charge. Non Governmental Organisations (NGOs), District level government agencies private entrepreneurs and banks were given the mandate to ensure the installation and monitoring of the targeted number of digesters within the approved budget. (AFPRO-CHF/PARTNERS report).

The report on biogas by India's Action for Food Programme outlined some of the major challenges that biogas dissemination in India encountered and the lessons learned from those encounters. These have been summarized into four main challenges in this chapter. The first vital observation was that, the end users of biogas: majority of who were women did not have any representation in decision making. This meant that any ideas they would have contributed to improve quality or even increase the benefits that users of biogas get was being foregone. The report emphasizes the strong role women play in order to have a digester constructed in their own households since almost all the men resist the idea in the initial stages.

The literature about biogas in rural China did not indicate how the views of the end users were integrated into the Central government's developments plans regarding biogas although it did make mention of ongoing research and development to improve consumer benefits of biogas in rural China. One cannot tell if this is due to a lack of freedom of expression in the country as is usually alleged by the media or that the biogas dissemination programme in China simply isolated end user feedback.

The second challenge of the Indian biogas programme was how to accurately estimate the cost effectiveness of using biogas. Most of the users did observe that their kitchens were not as smoky as was the case prior to acquiring the digesters, they also realized the excess time now on hand but the problem how these benefits could be converted into monetary values in order to back the main arguments. Also to be mentioned, was the fact that most of the biomass (firewood) that was used by the rural inhabitants was collected free of charge from their surrounding vegetation, this makes trying to convince them to invest in a digester quite complicated since they get the biomass practically free of charge.

In China too, an earlier appropriate technology called the "Improved stove" mentioned previously: which was very well adapted to the rural way of cooking, meant that the central government had to heavily subsidize biogas digesters in order to attract the users interest (Jing Ming 2007).

Third Challenge was how the use of biogas could effect a positive change in the rural environment. There was sufficient evidence to suggest that using biogas drastically reduces carbon dioxide emissions into the atmosphere as compared to using fuel wood. The studies also confirmed that using biogas implied that deforestation was curbed and that animal dung and biomass that was left after harvest remained untouched in the soil and not collected to be used as fuel as was the case. This prevented the occurrence of leaching and soil structure destruction (AFPRO report 2000). The fact still remains though, that the domestic size digesters that were and are still being used by individuals, do not produce sufficient gas to cater for all the cooking needs of the families. Therefore biogas users in the region still depend on the fuel wood and collected dung to supplement their energy needs.

The one practical way to tackle this issue is to fit the digesters with balloons that will store excess gas for use later; however these balloons are custom made and cost a fortune hence even large institutions struggle to purchase the high priced balloon.

The slurry (effluent from the digester) is professed to be rich in nutrients that improve soil structure and nutrient content but these benefits have not been enjoyed by the owners of digester simply because of their failure to use it on their farms. The idea of having to handle fecal matter near their crops is not enticing hence it discourages a lot of the farmers from trying out the benefits of the very much praised slurry.

However a large number of those who used the slurry in rural India also claimed they did not see any improvement in their crop yield (AFPRO report 2000), this leads one to question if there is any truth in the soil repairing capabilities of the slurry or whether the claims are just a cliché.

The fourth and final challenge has to do with financing the cost of the digester. Under the AFPRO project, in accordance with Indian Ministry for Non Conventional energy Sources individuals who wanted to own a digester received a subsidy from the central government through near by rural banks. This subsidy reportedly delays which means that people had to pay interest on loans they had taken from banks while they waited to be handed the subsidy amount. Currently, the central government does not subsidize the digesters: meaning that new owners have to bare the brunt of the full cost of a digester. Few people have the means to do this hence the demand for digesters have dwindled considerably.

The issue of ownership then comes into play. The excessive subsidy especially in the case of China resulted in the abandonment of most of the digesters even when the minutest of technical faults is experienced. The same is the case in India too. Without the subsidy, it is next to impossible for the rural folks to afford the digester and yet the subsidy seems to interfere with their commitment to keeping the digester in good working condition.

4.4 Biogas dissemination in Ethiopia

Biomass is the main energy source in Ethiopia. As at 1984, the consumption of fuel wood was an estimated 700kg per capita per year with demand reaching twice the supply in 1987 (Sustainable Energy Systems And Management, SESAME report 2008). Biogas dissemination in Ethiopia was therefore and still is a result of the government initiative to increase modern energy sources to a greater number of people in the country. Only an

estimated 2% of the rural population in Ethiopia is currently on the national grid (SESAM report). The country is very much endowed with several renewable energy sources including wind, solar and wind energy, however for some reason; these have not been sufficiently tapped. This may be attributed to the country's rather low energy consumption per head (28KW/per head) emanating from exporting mainly primary goods and no processed or manufactured goods at all (SESAM report).

Biogas has been marked to hold potential for sustainable development in Ethiopia. The many benefits that the government hopes to enjoy from the biogas digesters are outlined below.

The first is a decrease in the country's foreign exchange needs as petroleum is substituted for other forms of energy. This expected decrease in the country's foreign exchange demands may however be very insignificant since the domestic biogas production barely provides the energy needed by families to cook and light their homes in most of the countries where biogas is used: two cases in point are China and India. This shows that owners of functioning biogas digesters still depend on fuel wood and petroleum though to a lesser extent. Also, a large percentage of the petroleum that is imported is mainly for transportation purposes whereas biogas technology in the south has not yet ventured into transportation. Using biogas can therefore not influence the foreign exchange demands as is envisaged.

The second expected benefit is that using biogas would release labour that once tirelessly supported the traditional energy into productive sectors of the economy.

Releasing of labour (such as those involved in collecting and trading in fuel wood), into more productive sectors of the economy may rather increase the unemployment levels in the country. In a country with limited manufacturing going on, relieving any group of people from their livelihood activities will increase unemployment and decrease labour productivity since all the excess labour will be absorbed into the primary sector of the country which is already highly inefficient due to its extensive nature (extensive farming).

Biogas technology is also envisaged to increase innovation among the people and establish industries, such as factories that manufacture biogas compatible appliance. That may be possible in the foreseeable future but then in the short term; priority must be to invent ways and means of increasing local demand for biogas technology. When demand is high the other industries will spring up naturally.

The fourth projected benefit is the rich manure from the effluent that would help to reduce expenses on artificial fertilizers. The problem with this slurry is that farmers from other areas, specifically, China and India refuse to use the slurry because it is fecal matter. The chances that Ethiopian farmers will use the slurry less reluctantly is as at yet not known and besides that, some farmers in India have reported that they did not witness any increased yields from their farms as expected. This benefit is therefore hanging.

The Biogas technology took shape in Ethiopia in the late 1970's. As at 2000, an estimated 350 digesters have been constructed in the country with several of them being on pilot basis and funded by the central government and NGO's (SESAM report 2008).

The efforts to disseminate biogas in Ethiopia, has faced several challenges from the beginning and still does up to date. The main challenges are economic and technical in nature.

As is the case with any biogas technology project anywhere in the world, Ethiopia lacks funding. The cost of the digester is more than what the rural folk can afford for that reason almost all the domestic digesters were fully funded by NGO's. This kind of funding does ensure the progress of the biogas project; on the other hand it creates serious ownership issues taking a queue from China and India. It is very important that owners of a digester are made to contribute to the construction one way or the other in order to foster a sense of ownership in them.

The technical challenges faced were in the form of a lack of skilled labour to construct the digesters, technical support for broken down digesters and the inability of the owners to properly charge the digesters. Water shortage in the countryside is also a challenge since water is needed to charge the digester. (SESAM report 2008)

These technical challenges are to be expected in the initial stages since the biogas technology being used is imported from else but with time personnel can be trained to provide support services for broken down digesters. Also with a little more investment from the government and NGOs in to more research and development the digesters and the technology itself can customized to suit the needs of Ethiopian users.

4.5 Biogas in Nigeria

Nigeria is a major exporter of oil and also very rich in fossil fuels: what then could have sparked an interest in biogas technology in Nigeria? The fluctuating nature of oil price on the world market and the increasing awareness of the impact of fossil fuel combustion on our environment are some of the reasons given by (Akinbami et al. 2000. Over a half of Nigeria's population of approximately 124 million is rural and two-thirds of the energy consumption of the country is mainly fuel wood in the form of charcoal (Akinbami et al. 2001). The high demand for fuel wood is due to petroleum shortages both in the urban and rural areas. With an estimated population growth of 2.8%, this has meant that the demand for fuel wood is ever rising against a fixed supply thus creating a deficit. As at 1992 Nigeria accounted for 62% of total fuel wood production and consumption in the whole of West Africa (Akinbami et al. 2001).

Could there be another reason behind Nigeria's interest in biogas apart from energy, considering that the domestic digesters are seldom able to meet the basic cooking needs of the users. Studies have shown that a whopping 1.77 million tones of solid waste is generated annually in the country and biogas technology has been marked as a promising way to tackle the waste. Using biogas technology to produce gas is not in the pipeline however there are few pilot projects for research into waste management (Akinbami et al. 2001).

The challenges that have been encountered in Nigeria during their biogas dissemination programmes are very similar to those faced elsewhere in China, India and Ethiopia: issues with high cost of the digester, support services to maintain the digesters and people's difficulty to embrace the technology.

As usual, the initial cost of acquiring the digester is a major stumbling block as the rural folk and the intended users are often too poor to come up with the lump sum. The ownership of the digester then comes into play. When the digesters are funded through aid, the users fail to take proper care of it which may be because of they feel no sense of ownership.

Issues relating to maintenance of the digesters also come into play. During the wet season, maintaining an internal temperature higher than 15 degree Celsius inside the digester becomes a hurdle yet it is a very important condition that must be satisfied if the digester is to function properly. In the future, research and development will have to be geared towards customizing biogas technology to suit local Nigerian conditions.

Another challenge is how to come up with a practical way to collect the cow dung. The cattle are not kept in kraals but rather the traditional nomadic way of rearing cattle implies that farmer and cattle are always on the move in search of fresh grass hence it becomes rather difficult to accumulate the dung. One way out of this dilemma as suggested by (Akimbani et al. 2000) is to host the cattle at permanent central points for easy accumulation and collection of the dung. On the other hand, should people be disjoined from their tried and tested ways of living just so that a technology which is yet to prove itself as an efficient means of producing energy can be propagated?

We need however to be mindful of the fact that man has evolved to the stage in which he is now as a response to the challenges around him so probably it may be time to evolve again in response to an era of energy shortages and unprecedented environmental pollution.

The final but very critical challenge is the people's resistance to change. A lot of the rural folk have simply declined to try out the some what new technology. When people start witnessing firsthand, the benefits they can enjoy from switching to biogas technology they will be motivated to embrace it.

4.6 How Biogas Has Influenced the Living Standards of some Rural Women in the Developing World

Using biogas has no doubt improved the lives of several thousands of women around the world who have tried out the biogas technology. This section is just a recount of some of the several testimonies that have been recorded from such women in developing countries.

In the Action for Food Production (AFPRO) report: Indian Perspective on biogas and the lessons learned, the women in villages at Uttar Pradesh India, who were interviewed could not help pointing out how their time spent on cooking meals had decreased dramatically. The long hours spent searching for firewood had become a thing of the past.

The search for firewood was even longer in the dry season when vegetation is scanty and in the wet season the firewood is too fresh hence it takes a much longer time to burn and produce the fire needed for cooking. According to the women, all they have to do now is to ensure that there is enough biomass in the digester. The excess time on their hands is now

spent caring for their children, sending their children to school or catching up on lost sleep time. These are all things the women could not do in time past.

The AFPRO report also documents the women from the rural areas of Tamil Nadu, India testifying that firewood shortage has become a thing of the past. Previously, the dry season was a hard time for women since there was not enough firewood for their cooking. This meant that meals were delayed and their husbands often got violent when agitated by the situation. Several women admitted to having been beaten by their husbands because meals had delayed, however since they (women) started using biogas, no such delays have occurred.

Both the AFPRO report and Hervie (2008) gave extensive reports of women being very happy about the clean nature of biogas. This supposed clean nature of biogas was described in two ways. According to the female cooks on the Valley View University campus (Hervie 2008), their cooking utensils were no longer coated with black soothe from burning firewood and this made cleaning up after cooking very easy.

The rural women of Tamil Nadu and Uttar Pradesh, India, also talked about how their kitchens, utensils and clothes were now comparatively cleaner, thanks to biogas (AFPRO report). This meant that the kitchens were no longer an isolated shed on the household compound, far from the residential housing. Kitchens were now attached to the main housing and proximity problems were solved.

The second dimension of the clean nature of biogas that was discussed by the rural women is how biogas takes care of their sanitary conditions and pollution. In the AFPRO report the rural women of Tamil Nadu, India said that, they no longer had to worry about how to dispose off fecal matter. Now all they had to do was feed it (fecal matter) to the digester which then recycles it to produce much needed fertilizer for their crops. The rural women of Uttar Pradesh also said that they did not have to handle cow dung anymore since there was no need to make dung cakes for setting fire, thanks to their new biogas stoves.

The smoke free nature of biogas also meant that very few incidents of smoke related diseases (respiratory diseases) were reported in the villages. The women of Uttar Pradesh who were interviewed, according to the report, also said they did not smell of smoke every time as they used to. Zeleke (2008), further points out, how there have been dramatic reduction in the cases of respiratory illnesses caused by excessive smoke from firewood in rural areas in Ethiopia. The reduction was due to the introduction of biogas to the rural communities.

Another benefit derived from using of biogas by the women, is under the intangible concept. It has to do with emotions. The rural women from Uttar Pradesh who were interviewed said

that they no longer felt inferior to the urban women because they now use biogas stoves, which are similar to LPG stoves (AFPRO report).

The women went on further to say that their husbands were no longer agitated over delayed meals because meal times seldom delayed.

The women claimed their husbands were now helping them in the kitchen sometimes because of the smoke free nature of the biogas stove, all these created very good rapport at home for them (women).

The fear of being at risk of snake bites during firewood collection was also now a thing of the past, according to some rural women in Tamil Nadu, (AFPRO report).

Finally, regarding monetary benefits, the biogas training programmes after all is said and done, did equip some of the rural women with skills such as masonry, plumbing and basic mechanical engineering skills for maintenance of biogas digesters. These programmes created employment for several of the rural women thus helping them to contribute some extra income to support their families. It also made them feel important and independent (AFPRO report). The report further gave the example of one such woman who said her husband stopped beating her because she was now bringing in more income from maintenance work on biogas digesters in her village in Uttar Pradesh than her husband did. She was very happy with the independence and respect that her new skills had earned her in her village and surrounding villages as well.

Although almost all texts give positive testimonies of biogas being an alternative energy source, one cannot help wondering why all governments are not embarking on massive drives to make biogas the fuel of the future.

But then again, looking at China and India it is obvious that a serious problem of ownership in terms of lack of commitment to the projects did occur simply because the central governments opted to subsidize the cost of the digester for their people.

4.7 Summary

From the literature so far, it is evident that biogas technology is very beneficial to the poor. The gas is able to meet their cooking and lightning needs to a large extent but the poor are unable to afford the biogas digester without some external funding from either the government or an NGO. The high income families who can afford to own the domestic

digester have higher demands for energy which the domestic biogas digester cannot currently supply. The paradox is therefore that: those who need and appreciate the domestic digester cannot afford it and those with the income to purchase the domestic digester have energy needs which the digester cannot satisfy at the moment.

Secondly, in all the success stories in China and India there is or perhaps was some form of subsidy from the central governments. The experiences with biogas of some African states like that Ethiopia and Nigeria as mentioned above have not been so successful perhaps due to the lack of subsidies to help acquire the digesters.

The problem is that this subsidization of projects interferes with people's commitment to the digesters. Because owners only had to pay a very small amount especially in the case of China and India, they did not feel that they owned the digesters hence owners did not bother to find a way of repairing several of the digesters that broke down, in the case of China this was over 300,000digesters. (Jing Ming 2007).

The dissemination of biogas technology has been successful in some countries than others. From the literature, it seems that biogas technology has enjoyed comparatively more success in the Asian countries like China and India than it has in the African countries of Nigeria and Ethiopia. This observation may however not be significant since the Asian biogas projects commenced decades before the African biogas projects did.

It is worth pointing out though, that the African examples that were reviewed in the literature were mostly digesters that have been constructed in educational institutions for the purpose of research unlike the Asian examples that were mainly for domestic use.

The fact remains that all the projects have experienced the same challenges the most prevalent being funding for the domestic digesters. In China and India the governments of both countries took up the mantle of subsidizing the cost of the digesters so that poor rural folk are able to afford a digester. In the case of Ethiopia subsidy was provided mainly by NGOs but in Nigeria digesters are owned by institutions rather than individuals so funding is not as much a problem to them (institutions).

There is also the challenge of lack of technical support for maintenance of broken down digesters. The Chinese government tried to address this problem by integrating biogas technology into their school curriculum and this helped to curb the problem to an extent.

In India NGOs set up training centers to train biogas digesters maintenance personnel and this move even helped to create hundreds of jobs for the rural people of Utter Pradesh according to the AFPRO report.

In case of the African examples because the usage of biogas technology is not comparatively widespread and also not supported by the government as is the case in the Asian countries mentioned, there is still very little maintenance personnel available to repair broken down digesters.

Finally the willingness of people to embrace the seemingly new biogas technology is a challenge because the projects have faced a lot of resistance from the people they (project) were intended for.

CHAPTER FIVE

DATA PRESENTATION AND ANALYSIS

5.1 Introduction

This chapter attempts to present and analyze the data that was collected during the fieldwork. There are two sections in this chapter: the first section presents the data in subtitles that try to understand how and why the various people interviewed decided to use biogas. The section will also look at who the main users of biogas are in Ghana, the main modes of digester acquisition and maintenance and finally how using biogas influenced the rural women of Appolonia as compared to the women from other developing countries discussed in the third chapter.

The second section is sub-divided into two parts. The first part will discuss the major challenges that stand in the way of sustenance or longevity of biogas projects in Ghana. In the second part of the second section I attempt to discuss the way forward in terms of how biogas projects can be sustained in the future.

SECTION ONE

5.2 Introduction

Prior to starting this research, I heard of and watched the numerous benefits that biogas technology had to offer on a National Geographic programme and that was when I started wondering what experience Ghana has had with biogas. Before going to the field the following were the questions that came to mind:

- What caliber of people had some experience with biogas?
- What kind of experiences have these various groups had with biogas?
- How did their experiences with biogas affect their standard of living?

The rest of this section tries to present the answers to the above questions as given to the researcher by the different respondents.

5.2.1 Users of Biogas Technology in Ghana

Initially my main agenda was to hold interviews at Appolonia community (pilot project to test feasibility of adopting biogas technology in rural Ghana), and the Head of Achimota school (where I was certain biogas was being used), then the Valley View University (VVU) and the Kwame Nkrumah University of Science and Technology (KNUST). This is because I had read online reports about the existence of biogas digesters on both campuses.

However during my interview at VVU when I inquired from my respondent if there was any existing organization that supervises biogas dissemination in Ghana the following was his response:

"Well, there is a national association of biogas experts who meet to share ideas about the best use of digesters etc... Most of them are scientists from the Centre for Scientific and Industrial Research (CSIR), KNUST, Kumasi Metropolitan Assembly (KMA) and Tema Municipal Assembly (TMA). But there is no organizing body that supervises digester installations."

The above response was very surprising and encouraging as well. It implied that there must be quite a few biogas projects in existence than had imagined. The existence of such an organization also meant that government of Ghana has expressed some form of interest in biogas technology. I say so because the CSIR which my respondent mentioned was involved is the main research wing of Ghana and most of their research projects if not all are funded by the Ghana government. So probably the government is doing more in terms of funding biogas dissemination projects than it appears.

From the interview at VVU, I decided to follow up on the references and successfully scheduled interviews with staff of the refuse management department at TMA. The decision to choose TMA among the lot was based on the fact that Appolonia community which I was studying was under the jurisdiction of the TMA. I also had the privilege of viewing another community biogas project at Kotoku a suburb in Accra, Ghana.

On my way home from one of the interviews I stumbled upon a company that was advertising to be a biogas technology provider. I received audience with the sales manager of the

company, a young man, who willingly gave me some useful insight into who their main customers were. Could there be more biogas projects in Ghana than I had imagined? Because this sales Manager mentioned several institutions to which they had offered their services.

From the above interviews it became obvious to me that the main users of biogas in Ghana were companies or relatively large institutions in the urban centers who could afford to purchase the biogas digester. These were mainly tertiary institutions and hospitals.

I was duly informed by one scientist from the CSIR that there were several examples of biogas being utilized by rural communities. However the technology has been harnessed solely for managing human fecal waste hence Appolonia is the only example where biogas was used by rural people for domestic purposes such as cooking.

In all the other rural examples apart from Appolonia community, the residents do not use the biogas for domestic purposes. The digester is connected only to the public place of convenience to help manage the human waste. The gas that is produced only provides electricity for the public place of convenience. Initially I assumed that probably the cost of channeling the gas from the public latrine to the individual homes of the residents may be the reason why the gas was not being utilized by the residents of Kotoku and others like it.

If cost is the main problem why don't they sell the gas in portable containers to the resident as is done with LPG (Liquefied Petroleum Gas) in the urban centre?

Investigations as to why this is so revealed that biogas by virtue of its particulate nature needs to be compressed before it can be put into portable containers as is the case with LPG. The process of compressing increases the cost beyond what rural people can afford and hence renders it not competitive cost wise.

From my own observation I realized that domestic utilization of biogas in Ghana even in the urban areas is rare. The interview with the salesman also revealed that after five years of operating, their main customers were institutions like the Ghana psychiatric hospital, Regent University (a privately owned university in Ghana) and some other private companies with only a couple of clientele wanting . I could however not get him to reveal the identity of these customers for a follow up interview with them due to privacy issues.

In short, biogas is not patronized very much in Ghana. The few who use it the urban areas mainly use it for research purposes or for waste management in large institutions. Urban use of biogas for domestic purposes is very rare.

However, currently biogas is used in quite a handful of rural areas for waste management purposes. Appolonia is the only example of a rural area where biogas was used for domestic purposes but that project is no longer ongoing.

5.2.2 Reasons for Choosing Biogas Technology

Biogas technology has many uses, lighting cooking and also for waste management to name but a few. The institutions, communities and individuals all chose to use biogas for very different reasons.

At Appolonia I found out that the community was chosen by the government of Ghana for the pilot project of testing the feasibility of using biogas as an alternative energy source in rural Ghana. Since the locals were cattle herders it was assumed that dung for charging the digesters would not be an issue.

From my interview with nine locals it became clear that the locals were in no way involved in the decision to bring the biogas project to their community. They were sheer beneficiaries who only witness the project spring to life, without being given any form of education as to how they could maximize their benefits from the project.

However Hervie (2008) in the SESAM report on Energy and recommends that rural women be involved in decisions concerning them since it increases their participation level and also helps to know their real needs. But is it plausible that the government of Ghana could just commence a project of such magnitude especially considering the financial investments involved without informing anybody in the community at all?

Perhaps only the consent of the chief was sought and he on the other hand only informed the community members about it rather than engaging them in discussions. However I did not get the opportunity to inquire from him whether or not he was informed since it would require a lot of time to get audience with him and I had very little time. One thing remains certain though: the people were only informed about the project but their consent had little to do in the matter.

Achimota School adopted the technology as a means of cutting down their expenses on Liquefied Petroleum Gas (LPG) hence the main intended purpose of the gas that would be produced was cooking. The raw material for producing the biogas is freely available to the school hence that would not be a problem. It was also a way to tackle the liquid human waste. I learnt from the Head of the school that the project was put on hold when the school experienced an outbreak of cholera causing the death of two students. The Parent Teacher Association (PTA) had then voted that the project be shut down.

The news was baffling to me since biogas is produced under anaerobic conditions and as such any pathogens in the fecal matter are destroyed during the process. It is scientifically impossible for the Vibrio cholera, the organism that causes cholera to survive in the biogas digester; this was confirmed to me by one of the scientists from the Centre for Scientific and Industrial Research (CSIR, Ghana's main research institution responsible for research, development and dissemination) who accompanied me on the trip to Appolonia.

It might be interesting to know that at the time of writing this, seven months after my interview with the Head of Achimota School, the school is facing closure because their broken down sewage is deemed a health hazard to students and nearby residents. The sewage is choked with human waste and hence has spilled over onto the surrounding environs. This problem could have been prevented if a digester was attached to this sewage to breakdown the human waste as is being done at Kotoku and other rural public places of convenience.

The VVU on other hand went in for biogas technology because of the school's green policy. VVU in Ghana is a subsidiary of a larger family. Some of the campuses are based in the United States of America as well and all the campuses are compelled to follow this green policy. The biogas technology was a green way to tackle their sanitation problems and at the same time provide gas for cooking meals for the students. The effluent from the biogas production was also used to fertilize a nearby farm belonging to the school.

There seems to be the possibility that if the school authorities had their own way, they would abandon the use of biogas then, since the reason they gave for using biogas is to satisfy the institution's green policy. However, being green does not necessarily imply biogas. If their only interest was to adhere to the green policy then one can see that they had options such as solar panels and yet they willingly picked out biogas as their choice.

The biogas digester at the KNUST campus on the other hand was constructed for the sole purpose of research. It was to help develop gadgets hence the gas is not put to any specific use other than testing the gadgets such biogas cookers one of which I witnessed had been used at Appolonia during my interview session there.

This however is another evidence of the Ghanaian government expressing interest in biogas technology. I say so because first and foremost, KNUST is a public tertiary institution that engages in research programmes often funded by the government of Ghana through Ministry of Education. It is a fact that Ghana has some interest in biogas however the investment is at KNUST was not what I would call large scale. Investments into hydro electric power and even in the Rural Electrification project in Ghana are more massive than what I saw at KNUST.

At the Kotoku community, I did not interview any of the locals but I was informed by a scientist from the CSIR that the purpose for the digester was to tackle liquid human waste. My own observations showed that the biogas digester had been connected to the main public toilet of the community. With this project too the community members were not involved in the decision to attach a biogas digester to their public place of convenience however the project seems to be going on as planned and I wonder why that is so?

One explanation could be that unlike in Appolonia, the biogas project at Kotoku did not affect the lives of the locals that much and also that its sustenance was not dependent on them as such. Obviously the locals would have to use the place of convenience for the biogas to be produced but that was about the only contribution needed from them.

Secondly, we need to take note of the fact that the purpose of the biogas project at Kotoku was not to produce biogas but rather to manage human waste.

5.2.3 Funding for the Biogas Digesters

The first and major challenge faced during biogas implementation is financial limitations. According to Hervie (2008), though biogas has great potential in rural areas, they lack the initial investment required to construct the digester hence their inability to enjoy the immense benefits derived from biogas. (Akinbami et al. 2001) also acknowledged the major role income plays in the acquisition of a digester by rural families.

In general, rural communities engage in subsistence agriculture hence they have very little surplus income to spend on a biogas digester.

In the case of Ghana, the biogas technology sales man gave me very useful information regarding the estimated cost of constructing the digester. According to him the pricing was dependent on whether the client is an individual or an organization however he initially refused to give me the specific prices for each category. I was able to convince him to give me a price estimate. He said the cost of the digester is calculated per meter cubic and the amount each meter cube is 350USD.

He also hinted that the average home of four persons would need an 8 cubic meter digester. Meaning that the cost of obtaining a digester for the average home in Ghana will be approximately 2800USD (350USD multiplied by 8). Considering that the minimum wage in Ghana is as low as 1.3USD per day as at February 2010 it was understandable that the company had had only a couple of domestic clients since commencing business about five years ago.

It became quite plain after that interview that funding could be a major reason why individuals were not patronizing biogas technology in Ghana but is that the sole reason?

The women I interviewed at Appolonia were also an affirmation that lack of funding could a main reason why biogas dissemination is so slow. The total cost of construction of the digesters had been funded by the Ghana government through the then Ministry of Energy (Ammisah-Arthur and Amoonoh-Anamuah 2004).

Asked whether she would like to once again be able to use biogas and what was preventing her if yes, one of the women I interviewed at Appolonia replied as follows:

"Oh yes, the biogas helped me a lot and I want it to come back to us but I don't have the means to afford it, I make very little from the kenkey (Ghanaian food made from corn) that I sell."

One more testimony to the importance of funding in any biogas dissemination programme especially in the developing world.

Amongst all of the institutions I had the privilege of visiting; Achimota School is the only one that received funding for the digester from an external source. All the other institutions had acquired their digesters through their own means.

Achimota School on the other hand received their funding from the old students association of the school also known as the Old Achimotans Association (OAA). Each year a different year group volunteers to fund a project for the benefit of their almer mata. On one of such occasions the donation from the OAA had been dedicated to the construction of a biogas digester on the school compound to help reduce the school's expenses on LPG.

My respondent at the VVU on the other hand expressed how their institution struggled with the financing of their biogas project although the school made free use of digester engineers who were already lecturing at the school. My respondent even wondered how individuals will be able to raise the money involved.

The digester at Kotoku was a project being run by the CSIR to test the waste management abilities of the biogas technology hence it was government funded through the CSIR.

During my interview with the sales man from the biogas technology company, I tried to find out if he knew how their clients paid for the digester, he replied as follows:

"Well, as far as I know they pay for it themselves."

Though the initial cost is high, in the long term (30 years down the line) users of biogas will tend to make a lot of savings since generally with good maintenance the biogas digester can last for over 50 years. The cost of 14kg of LPG is 10USD and the average urban Ghanaian household uses on the average 14kg of LPG every month.

Using the estimated cost of a digester given to me by the biogas sales man, the cost of the 8 cubic meter digester will 2800USD as calculated in the previous paragraph: and the amount spent on LPG per year by the average Ghanaian family will be (10USDX 12months) 120USD.

The table below illustrates the savings that a family of 4 can make by reverting to biogas in 50 years.

Table 5.1: Estimated savings to be made when a family of 4 uses biogas in Ghana

Time period	Cost of LPG in USD	Estimated Savings in USD
12 months	12x10USD=120	120-2800= -2680
20 years	20x120USD=2400	2400-2800=-400
30 years	30x120USD=3600	3600-2800=800
50 years	50x120USD=6000	6000-2800=3200

Source: Fieldwork

From the table, it is obvious that in the short run there is no savings but then in 30 years there is a lot of monetary savings and considering that the analysis is even based on the assumption that prices are fixed the amount shown in the table is an understatement of both the monetary and non monetary savings that can potentially be made. Inflation is currently about 21% hence there is even more savings to be recouped from using biogas.

However, considering how low the level of income is in Ghana it is very difficult for the average Ghanaian to afford the huge sum needed to acquire a digester for domestic purposes. Though one tends to save in the long term, the initial lump sum investment needed for such a projects is too large for the average Ghanaian to foot without funding from an external source.

Even the institutions I interviewed struggled with the cost involved in the construction of their digesters therefore individuals need a lot of motivation in order to entice them to use biogas: whether through the banking system or directly from the government.

5.2.4 Ghanaian Experiences with Biogas Technology

After using biogas how the users perceive it as an alternative energy source is a very important piece of information that can help to know if biogas technology would continue to enjoy patronage from current users and future ones as well.

At VVU, the scientist I spoke to said currently biogas is able to provide only 30% of their total energy needs however plans are underway to increase biogas production. They plan to do this by channeling all the toilet facilities on the school campus to a central pit that is

connected to the biogas digesters. Currently only the main administration block is connected to the central pit.

School was not in session during my interview so I did not get to interview the real users of biogas at VVU, which are the cooks. However from the SESAM report by Hevie (2008) reports that the cooks who were all women complained that the flame from the biogas was comparatively weak hence it took longer time for meals to get ready compared to Liquefied Petroleum Gas.

I tried to find out what was causing the weak flame from one of the scientists at the CSIR-IIR (Centre for Scientific and Industrial Research- Institute of Industrial Research) who was himself an engineer working on biogas burners. He explained to me that the gas that is produced from the digester has not been compressed yet hence the particles are more apart compared to LPG. However, compressing biogas adds to the cost and decreases its competitiveness as an energy option.

The VVU is obviously planning to increase their biogas usage which is very commendable but as to whether they are doing it because they are impressed by biogas technology or just following the school's green policy is uncertain. However one thing is certain, which is that,

funding the biogas digesters has been a herculean task for the school.

Figure 5.1: The biogas digesters at Valley View University campus

At Appolonia the women highly praised the biogas. One elderly woman who was in her late sixties narrated how her business of kenkey selling (kenkey is a Ghanaian staple made from steamed corn dough). She said:

"The gas was smokeless and fast so I could cook several batches of kenkey a day. I could sell late into the night too because the street lights were on and people came out to buy. When there excess gas which was very often I would call my neighbour to come and use it if she needed it."

However I could not help but wonder how come these rural women were so fascinated by the biogas and how it enabled them to cook fast thus decreasing their time total time spent on

cooking. Yet at VVU reports from the SESAM programme (Hervie 2008) claimed that there were complains about the weak nature of the biogas flame? What could be the explanation behind this contrast if the same technology was being employed in both cases?

It could be that each of the two groups was comparing biogas to a different fuel.

In the case of VVU, biogas was being compared to LPG whereas the women at Appolonia were comparing biogas to firewood. Probably the rural women who were accustomed to using lower technology were slightly more impressed than their counterparts at VVU kitchen and that may be the reason behind the different impressions about the biogas flame.

At the time when biogas was still being used at Appolonia, the household had to pay a monthly fee equivalent to 1USD in current terms. This amount was used to purchase diesel to operate the tractor that was used to collect the cow dung to feed each of the digesters. According to the caretaker who is a local resident in his early forties, some refused to pay while others could not keep up with payment, sadly the project was abandoned because the funds to maintain it was just not forth coming.

However I do recollect vividly from my conversations with at least two of women I interviewed that their businesses benefited a lot from the biogas because they could sell at night implying that their incomes had increased. Why then were they refusing to pay, if their incomes and increased and also if what the caretaker is saying is anything to go by? It may be the case that the monthly payment was too expensive even for their comparatively higher incomes or that their incomes had increased but not increased enough to afford the monthly

levy.

Figure 5.2: One of the electricity generators at Appolonia

Currently the generators are no longer being operated with biogas but rather with diesel and they are switched on only when a household needs light at night for a function such as parting and funerals.

It is perplexing however that under those circumstances mentioned above, locals are willing and able to pay for the cost of one gallon of diesel to the caretaker. When the generators are switched on not only the individual household that requested but the whole village is lighted. The cost of diesel as at June 2009, during my interview was 1.12USD per litre and this can only cater for one night of light which is quite costly for low income earners like the rural folk I met at Appolonia.

However I learnt from the caretaker that at least twice every week a household or an individual requests that the generators are switched on for their use. This piece of news really attracted my interest because it could be an indication that the monthly payment was not beyond what the people could afford. The monthly levy was the equivalence of 1USD

whereas the cost of a gallon of diesel; the quantity needed to for lightning one nights function is 1.12USD. Obviously the people could afford to pay the monthly levy. Why then were some of them refusing to pay?

Interestingly enough all the women I interviewed claimed they had no idea why the biogas stopped flowing to their homes and that they had kept up with payments. Who then was to be trusted in this case because in this case it is the women's words against the caretaker's?

In their work on renewable energy in Ghana, (Amissah-Arthur and Amoonoh-Anamuah 2004) suggested that the project came to an end due to lack of feedstock to charge the digesters and also blocked pipes. However from my own observation which was also confirmed by the caretaker, a lot of cattle herding goes on in the village. In his own words the caretaker said:

"Oh the dung was in abundance, the herders were always begging me to come with the tractor to collect the dung from the kraals because it was piling up".

The evidence suggests therefore that there is more to it than just lack of feedstock.

Pondering over the second reason given by Amissah-Arthur and Amoonoh-Anamuah, I came to the conclusion that the blocked pipes could be because of lack of maintenance due to the funds that were not forth coming.

The ball is back to the issue of funding again. If the households in Appolonia can afford to pay for diesel to operate the generators why then could they not come up with the monthly levy that was needed to maintain pipes and distribute feedstock to all the digesters?

Probably those who were benefiting more, especially in terms of increased incomes must have kept up with payments whereas those who did not benefit financially could not or would not keep up with the monthly payments. Since the total amount needed from the people in order to sustain the project could not be met the project ended. That is how vulnerable the project was: its success was dependent on the cooperation of the residents of Appolonia.

So in short, some had to suffer because others did not or could not fulfill their duties to the community. These people who did not keep abreast with payments were not benefiting from a project that was supposed to be for them. They were not even consulted about the project in

the first place hence they did not feel any sense of ownership towards the project. But it seems those who did not benefit financially refused to pay either because they did not have the means or because they were jealous that some others were benefiting more than they were.

The biogas project at Appolonia could have been sustained if some of the people had been committed to paying the monthly levy that was very much needed to maintain the digesters, pipes and tractor used for collecting feedstock to charge the digesters.

This shows the extent of the vulnerability of the project. Its success and sustenance is highly dependent on the commitment of every member of the community and as such there has to be way for everybody to benefit equally in order to ensure their total commitment. However is it possible to ensure that everyone can benefit equally? It is the individual's own duty to identify business opportunities that biogas brought to their community and not the project coordinator's duty. However if everyone in the community was engaged in trading where would the demand for the goods come from? That is up to the beneficiaries to figure out how they can take advantage of the biogas for their personal gain because equality is a utopian concept that is yet to be achieved even in the highly advanced societies.

Figure 5.3: One of the broken down digesters at Appolonia

Figure 5.4: Biogas digesters at Appolonia choked with sand and rubbish

5.3 Biogas and the Standard of Living of Rural Women (The case of Appolonia)

5.3.1 Introduction

The biogas project at Appolonia when it was still on going benefited the whole community as one of the women I interviewed told me.

"When we had the biogas, in fact we were all overjoyed because of the many things we could now do!"

This section of the thesis is however only interested in what impact the biogas had on the standard of living of the women at Appolonia. The effects on the standard of living: as

defined earlier will be discussed under the main headings; incomes, farming activities and family life of the women.

5.3.2 Effects of Biogas on the Incomes of Rural Women

First and foremost the biogas increased the incomes of most of the women especially those who were involved in the selling of cooked food. This was because the long periods of time used in searching for and gathering firewood for cooking was no longer necessary. Cooking time was now shorter and with less stress involved so women could cook several rounds per day to sell thus increasing their income.

During one of the interviews one woman expressed with such nostalgia how business was booming in the days when biogas was still running through the pipes channeled into her kitchen.

"Sometimes I cooked four or five rounds of the kenkey a day. You can even ask the caretaker, he used to eat here free of charge daily and because of the streetlights I was able to sell deep into the night and customers would still come. My profits were high because the biogas was cheap."

The increased incomes implied that goods that were previously categorized as luxury were now within the reach of these women as one of the women explained to me.

"I could afford to buy books for my son to practice his reading and also pay for extra tuition for him at school."

The increased income was enjoyed mainly by those involved in some form of commercial activity but then those not involved in selling also benefited in other ways. For instance the streetlights that were lighted throughout the town benefited everyone regardless. Some of the

women even testified of how children were able to learn hours after dark. One interviewee summarized it better in the following way:

"My children could do their homework in the evening so in the afternoon after school they helped me with farming and housework."

The increased income of the women that was as a result of using biogas therefore came in two ways.

First those who were engaged in commercial activities were selling more of their wares because it is easier using biogas to cook compared to the strenuous activity of collecting firewood and also the availability of streetlights implied that they could sell several hours after dark.

Secondly, those who were not involved in commercial activities spent less time to cook when using biogas hence they had spare time to engage in farming or any other livelihood activities in which they were involved.

The second way in which using biogas influenced the women of Appolonia is some ways similar to how biogas influenced the rural Indian women. They also had spare time to make local cigarettes to sell thus earning additional income.

However unlike in India where biogas technology created jobs such as masonry and maintenance work for the locals, in the case of Appolonia there was no such creation of jobs among the locals. The sole job created was that of the caretaker who was in charge of maintaining the digesters and collecting dung from nearby cattle kraals to feed the digesters. Ironically, that single job created is still in existence since the caretaker still occupies that position. However the job description may have changed because currently he serves more as a watchman rather than a maintenance worker.

There was also no mention made of commercial activities involving biogas in India. For instance in Appolonia the women used the biogas to cook food and to sell at night under the streetlights. Available literature did not however make mention of any such activities in

China, India or for that matter any of the other countries mentioned in the previous chapters where biogas is used.

This contrast may be as a result of cultural differences. Probably in other rural areas around the world families prefer to cook their own meals rather than buy from a seller which might discourage anybody with such commercial intentions since there would be no demand for their wares.

Does this mean that only the rural women benefited from the biogas? (Amissah-Arthur and Amoonoh Anamuah 2004) mentioned in their work that a male bar owner at Appolonia commended biogas. The street lights brought customers even at night to his drinking bar thus increasing his sales of alcohol.

There may be several other examples of men benefiting one way or the other from biogas coming to the Appolonia. However the focus of this study is how biogas affected the lives of the rural women and that may explain why minimal reference is made to the effects that biogas had on the male residents of the community.

Figure 5.5: The researcher interviewing a female resident of Appolonia

5.3.3 Effects of Biogas on Farming Activities of Rural Women

As was the case in India the women of Appolonia I spoke to claimed that using biogas gave them valuable spare time which they spent taking care of their children and farming in the case of Appolonia.

Using biogas therefore gave women the opportunity to spend more time tilling the land resulting in higher yields whether for subsistence or commercial purposes.

Interestingly enough, even though the rural women in India praised the fertilizing potential of the slurry from the biogas production process, the women at Appolonia made no mention of it. One explanation for this could be because the women at Appolonia were not put in charge of feeding or maintaining the biogas digesters: it was the duty of the caretaker. For that reason they may not even know where the outlet of the digester was let alone going to fetch the slurry to fertilize their crops.

However the VVU lecturer I interviewed attested to the fact that the slurry increased farm yields at least in their case.

Secondly some of the women in India who used the slurry claimed they did not experience any increase in their yields. This could therefore mean that probably other factors such as nature of the local soil and type of crops being cultivated may all influence ability of the slurry to fertilize the soil. But this is only a hypothesis that needs to be probed further.

5.3.4 Effects of Biogas on the Family Life of Women

When stress levels are reduced it affects the general atmosphere at home. At least the women in Utter Pradesh, India praised the clean and smokeless nature of the biogas. The women said these qualities of the biogas meant that their husbands were often in the kitchen helping in the cooking thus creating a lively atmosphere. Also there were fewer quarrels between husbands and their wives over the issue of delayed meals.

This was however not the case for the women in Appolonia or perhaps it was. But if it was why would they fail to make mention of such an important benefit during the interviews? Due to lack of time I could not probe further to find out whether not biogas had influenced their family relations as well.

SECTION TWO

5.4 Problems of Biogas Dissemination in Ghana

5.4.1 Introduction

In this section of the chapter, the aim is to deliberate on the problems that have bedeviled biogas dissemination in rural Ghana especially in Appolonia. The main ones that have been identified so far are funding, and community participation and a lack of policies to support biogas dissemination. However this discussion will be done in comparison with problems of dissemination in the four countries previously discussed in the second chapter of this study. The section will also look at what ways to ensure sustenance of biogas dissemination projects in the future.

5.4.2 Funding, Community Participation and Government Support

The issue of funding seems to be the main setback of all the biogas dissemination progammes discussed in this study. In India, Ethiopia, Nigeria and Ghana funding has been a problem for rural people who attempt to use biogas. It is an established fact that without support from the government or NGOs it seems impossible for individuals in both rural and the urban areas to afford biogas digesters. With income levels so low in rural areas like Appolonia how then do you help them to acquire digesters and still get them to remain committed to the project?

Looking at both situations in India and Appolonia in Ghana, we realize that when the funds run out the rural people fold their arms and abandon their digesters. And yet we also realize that the biogas dissemination programmes in China and India have been the most successful so far. The one common feature present in both China and India was and still is government support through policy implementation. The countries where biogas dissemination has had little success also have one thing in common, no government support for the dissemination programmes. However in the case of Appolonia the whole project was solely funded by the government of Ghana: is that not a sign of government support?

The total cost of the biogas dissemination programme at Appolonia was 2700USD with an annual operating cost of 2300USD. The 2300USD was needed for maintenance and diesel for the tractor that goes round to charge all the digesters in the community and also for the wage of the maintenance worker who is referred to as the caretaker.

The government of Ghana may have funded the biogas project at Appolonia however there is no policy in the country currently that supports biogas dissemination. A one time project is not enough to encourage other rural areas to participate in using biogas technology. Even if the Ghanaian government has the political will to implement policies in support of biogas dissemination in rural communities around the country: does it have the financial will to back those policies?

In India banks NGOs were mandated to give out loans so that individuals could finance the biogas digesters themselves. This fostered a sense of ownership within the locals. Because of this sense ownership, they did not wait for someone else to feed their digesters for them daily as was the case in Appolonia. They also did not wait for the government to repair their broken down digesters: rather, they called on a local who had been trained to service broken down digesters. Why were the locals at Appolonia not trained to feed the digesters themselves as was the case in India and China?

The answer to the question above is very important because first the project at Appolonia ended because of a lack of funds. This fund was needed for two things: first to pay a caretaker whose only duty was to feed the digesters in the community with cow dung on the daily basis. Secondly it was needed to fuel and to also maintain the tractor which the caretaker was using to carry out his duties. So if rural people in China and India were able to learn how to feed their digesters why then did the people in Appolonia not able to feed their digesters? Since both cases are rural settings I cannot say that the biogas technology is too complex for rural people.

In their defense I could say that it is because in the case of Appolonia three households shared one digester and hence it was more of a communally owned asset. But then they could have run shifts with the feeding of the biogas digester and it still could have worked perfectly. Or perhaps they just did not feel they owned it simply because they were not consulted and because they contributed nothing towards the cost of the digester.

On the other hand it may also be failure on the government's part to ensure that the local people of Appolonia were involved in the project. Even if the government bears the total cost, they could have trained the locals to at least charge their own digesters daily and probably train a few of the locals to service broken down digesters as was the case in India and China.

5.5 Sustenance of Biogas Projects in Rural Communities in Ghana

Having been able to identify the major challenges that are faced during biogas dissemination programmes, this is where I try to discuss whether biogas projects in Ghana have the potential to last or not.

From the data gathered, it was obvious that a lack of funding could threaten the sustenance of biogas projects. For instance at Sakumono School Complex; the school that I went to for the purposes of finding out why they had not ventured into biogas, I was told that there was no funds to start such a project. However we also realized that the abundance of funding is also not an assurance that a biogas dissemination project will survive for long. A case in point is Achimota School. Achimota School's biogas project did not have problems with funding as was the case in Appolonia or even VVU yet the project ended due to a cholera outbreak as mentioned previously.

The two schools mentioned above; Sakumono School Complex and Achimota School are classic examples of groups that prioritize short run benefits above long run benefits. Evidently the head of Sakumono School Complex does value the savings that using biogas can bring to their school in the long run future as a result they don't see why funds should be diverted to a biogas project. If it is a mere lack of funds that is preventing them from using biogas, then they can go to a bank to seek a loan facility for the project.

In the case of Achimota School, they also do not see the long run benefits of using biogas technology if not, a mere outbreak of cholera will not result in their leaving the project half way to completion especially since all the funds that have been invested into the project so far cannot be recouped. Here again it may be lack of commitment because the funding came from an external source.

So far it has been established that individual funding for the digester is very difficult and yet when funding is from an external source it interferes with commitment. Funding is not the issue because in situations where funding is lacking and situations where funds are abundant there is still problem with commitment. Getting the beneficiaries involved in the project from the very onset could be a problem solver, even in situations where the funds are from an external source.

In Ghana, biogas projects are not dependent on funding but rather level of standard of living. The digester is expensive and can be afforded by a people at a relatively higher standard of

living. On the other hand these people who can afford it need higher energy than what biogas produces currently. The biogas that the digester gives is sufficient for rural communities that need energy for just cooking and lightning purposes. However they are too poor to afford the digester by themselves without any external source of funding.

The data suggests so far that for biogas projects in rural Ghana to be sustainable there should be funding but most importantly the beneficiaries should be involved in the project from the very onset.

The data also suggests that even in the abundance of funding, using biogas as an energy source can be sustained at very low standard of living like the level in rural areas for instance.

5.6 Biogas and Waste Management

It has been explained time and again by the scientists from the CSIR-IIR that biogas by virtue of its nature needs to be compressed before use and this act increases cost and decreases its competitiveness, why then should a developing country like Ghana with very limited funds invest in something that is not competitive in the first place?

Biogas on the other hand is a perfect way to deal with the current mounting human waste problem in city centres in developing countries. At the TMA department for waste management I was informed by a reliable source that all the human waste collected in the municipality is emptied in the sea. In his own words my informant said the following:

"The central point where all the sewage is collected broke down over five years ago and since then we have been dumping the sewage into the sea."

At least we know for a fact that using biogas for waste management purposes has been a success at Kotuku. Why then has TMA not adopted biogas to deal with their waste management crisis? The reply from my informant has to do with funding. This was how he put it.

"Actually several companies have approached us to construct biogas digesters for us to use. However when they bring in their proposals the amounts they demand is too much for the organizations tight budget."

Currently the TMA has no plans in the pipeline for any biogas projects because of lack of funds. This is where the government comes in. In the case of biogas waste management projects the investment required is one time. It does not require monthly levies either and hence makes it more competitive and efficient in the sense that nobody has to be paid to feed the digester not to mention the huge benefits to the environment.

Through policy and funding government can therefore show support to this alternative way of making use of biogas technology.

5.7 Summary

Biogas has many benefits for the lives of rural women however there are many challenges that are faced in most biogas dissemination programmes. These include lack of funds, lack of commitment to project and lack of maintenance, to name but a few.

Biogas as an energy source in rural areas can be sustained as long as their standard of living is low, however when their standard of living begins to increase, accompanied by purchasing of white goods biogas ceases to be a sufficient energy source. Given that one of the aims of development is to increase standard of living we can fairly say that biogas as an alternative energy source in rural areas is not worth the effort.

Attempting to compress biogas for it to be used more efficiently also makes it too expensive and hence not competitive. With the tight budgets that developing countries run it is very difficult for the Ghana government to continue funding rural biogas dissemination programmes. This however does not mean that biogas dissemination programmes have no hope in Ghana. When biogas technology is used for waste management it becomes competitive and all the issues of lack of community participation and funding cease to exist but above it is important that rural communities are engaged in any form of biogas project right from the onset.

CHAPTER SIX

SUMMARY AND CONCLUSION

6.1 Introduction

As stated in previous chapters the main aim of the study is to explore Ghana's experiences with biogas. This chapter therefore attempts to summarize the findings from the study and the conclusions made thereof in regards to the aims of the study.

6.2 Summary of Emerging Issues

Biogas technology no doubt has several benefits for rural women especially in regards to improvement of their standard of living. Biogas improved their family lives by creating spare time for them to spend more time with their children and other activities rather than going out to collect firewood. It also created opportunities for the women to earn higher incomes. Most of the respondents attested to the above benefits as discussed in the previous chapter.

The demand for biogas in Ghana in both rural and urban areas has however been very low over the years and the main reason for that is the huge investment needed to purchase the digesters. Simple analysis of the income levels of the average Ghanaian compared to the cost of a digester showed how difficult it is for average Ghanaians let alone rural people to acquire biogas digesters on their own. For this reason, one would find that majority of owners of biogas digesters in Ghana are institutions such as Universities and large health centres.

6.3 Problems that Affect Sustenance of Biogas Projects

From the study and available literature, it was established that biogas propagation in rural communities needs funding from an external source to cover the initial cost. Findings from the study also revealed however that because the funding was coming from external sources it made the projects very vulnerable. There lacked commitment from the beneficiaries because they (beneficiaries) did not bear the full brunt of the cost of the digester. They express this lack of commitment by not attending to the maintenance requirements of the digester or abandoning the digester immediately a technical fault occurs rather than getting it repaired.

In the case of Appolonia the sustenance of the project depended on a monthly levy that the beneficiaries were supposed to pay. The inability of the people to keep up with payments resulted in the project coming to an end. However the real reason behind the community member's inability to pay the monthly levy is not known. Firstly because the community members are able to afford the diesel to run a generator that lights the whole town: the cost of diesel for just one is approximately the same amount as the monthly levy. One can therefore safely say that their inability to pay the levy was definitely not due to a lack of funds. Secondly all those interviewed claimed they had kept up with payments. However those who kept up with payments were those whose economic activities were in some form boosted by the biogas. The conclusion that was therefore arrived at was that those who did not experience any economic advantage from the biogas did not see why they should pay the levy and more especially, pay the same amount as those who were benefiting economically. This is a sign of how people prioritize their short run benefits above their long run benefits.

It was also realized that even in instances where funding was available to subsidize the digester the success of the project was not assured. Other factors also dictate whether or not the project will be successful. One such factor is the availability of technical support to explain the technicalities of the digester to the users and also to provide after sales service to broken down digesters. Training of the users of biogas digesters in how to feed the digester and how to undertake simple repair work on the digester is also a must since that can cut down the cost of projects. This will ensure that fewer digesters break down and even when they do the digesters will not be abandoned by their owners.

Another factor that affects project sustenance is the kind of leader that oversees the community. When community members are involved in decisions or projects in their community that affect them, they tend to be more proactive. However when leaders isolate themselves community participation becomes very low as was the case in Appolonia. The community not was consulted about the biogas project prior to its commencement they were only informed that the project was coming. Therefore those who did not benefit economically from the project may not have received any prior knowledge from the leader as to how they can fully benefit from the biogas project. One cannot therefore blame them for not keeping up with the payment of the monthly levy.

Secondly when the level of education of the community is high especially that of the leader, mobilizing the members to participate in projects is not a herculean task. The benefits of the project are plain and clear to the people whence they are more willing to give their best.

6.4 CONCLUSION

The study is based on two hypotheses. First, that biogas does improve the standard of living of rural communities especially women. Secondly that rural biogas projects are sustainable.

The study revealed that the women at Appolonia did in fact experience some improvement in their living standards. The long hours spent on the preparation of meals was reduced since women did not have to go in search of firewood. Children could do their homework even at night because there was light.

Those whole sold cooked food saw an increase in their incomes because they could cook faster and hence sell more in a day as compared to when they had no biogas. They stayed out late to sell since there were biogas powered street lights that were lighted at night. And also the extra income from selling was used for paying for extra tuition for the children to improve their performance at school. The evidence therefore totally supported the first hypothesis.

The data however did not support the second hypothesis. Firstly it was realized that a biogas project is a very expensive venture that is not easily affordable to rural people and that even with available funding to cover the initial costs most biogas projects were not sustained. However obtaining funding from an external source for the project also interfered with the people's commitment to the project but involving the beneficiaries in the project from the very onset increase their participation and commitment to the project. The project at Appolonia was not sustainable. It was vulnerable and depended heavily on the cooperation of the beneficiaries.

Secondly, it was realized that biogas projects in rural areas can be sustained only if the funding is continuous. However this condition is very difficult to achieve and to maintain especially in developing countries since they usually have a tight budget to stick to.

Thirdly, the domestic biogas digester can only produce up to a specified quantity of gas, hence at lower standards of living, when all that is required is gas to cook and light the home

the gas produced is sufficient. However when the standard of living begins to increase and energy requirements increases: with the purchase of home appliances like fridges and television sets then the gas is no longer sufficient.

The conclusion therefore is that, with a continuous flow of funds, biogas projects in rural communities can be sustained only when the people have a very low standard of living: and given that developmental efforts aim at increasing the standard of living of those it is geared at, trying to get rural people to use biogas as an alternative energy source does not meet developmental goals.

The evidence rather suggests that biogas technology is more competitive and sustainable at least in Ghana when it is used for waste management rather than as an alternative energy source. In rural communities where digesters were attached to the public place of convenience the projects have been successful because it was not dependent on the community members per say.

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Appendix (i)

INTERVIEW GUIDE

The purpose of interviewing in this research is to find out people's experiences and opinions about biogas as an alternative energy resource.

Secondly to find out why biogas is not being harnessed by some groups of people (rural women and their communities) one would have thought it (biogas) would have been useful to.

And finally to find out from these selected rural women how they think biogas can be improved so they use it better.

The questions below will serve as guidelines for the interviewer hence the wording during the individual interviews will not be similar but the meaning that is intended will be adhered to. It is important to remember though that these questions are only serving as guidelines, hence depending on the answers the interviewee gives more interaction could be generated.

There are two categories of questions. The first which is category (A) is aimed at those interviewees who are already acquainted with biogas usage. The second category (B) will be directed to those interviewees who are currently not using biogas.

A)

- For how long have you been using biogas?
- How did u encounter biogas?
- How did you raise money for your biogas digester?
- Do you have any idea how the other biogas users in your community funded their digesters?
- Is there a particular company in charge of biogas digester installation in your local community?
- Do you know if this company is making a lot of profit from the venture?
- Why did you choose biogas considering all the alternative energy sources you could have opted for?
- What purposes does biogas serve in your daily activities?
- Before turning to biogas how were you dealing with those daily activities?
- Do you find using biogas a complex activity?
- What problems do you encounter when using your biogas installation?
- Do you know of any difficulties that people using biogas in your community have encountered?
- Is there something you would like researchers or scientists to change about biogas in order for it to better suit your needs?

B)

- Do you know of people in your local community who use biogas?
- Have you any idea how those people acquired the biogas digesters?
- Do you know who is in charge of installing biogas digesters in your community, whether an NGO or the government?
- Have you any idea if those in charge of the installation are profiting financially from the venture or not?
- Do you know if the own the biogas digesters willingly or not?
- From an observer's view point; do you think those who use biogas in your community have problems with the technicalities of biogas usage?
- Do you, as an individual think that biogas usage involves too many complex technicalities?
- Apart from financial reasons are they any other reasons why you have not opted for biogas?
- If you had a choice to choose any other alternative energy source what would it be?
- Why would you choose biogas?
- Or
- Why would you not choose biogas?